Concrete

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Fire-Prevention Week and the Builder

The building fraternity—engineers, architects, constructors, the building trades, and material men—can go a long way to carry out the idea behind Fire Prevention Week. They cannot reduce losses due to carelessness. They can reduce the hazards that create losses as a result of carelessness. They know how to create cities, towns, and farms that will not burn, and it is up to them to do so.

It is one thing to legislate against firetraps, but it is another thing to see that the spirit of protective codes is enforced to the last degree. It is just as necessary to sell people on the idea of fire-safe construction when the local code has failed to develop to the most modern state, as it is where no codes are available. It is the responsibility of the building fraternity to insist that every job be a fire-safe job, to promote good roads as a measure of fire protection, and to keep the costs of fire-safe structures within reach of all. It will not only be a public service, but well worth the while of the construction industry, and every individual therein, if constant work in the direction of fire-safety were carried on. There is nothing to lose,—but much to be gained.

Fire-safe construction can become a reality only when fire-safe construction becomes obligatory. People are willing to save on the first cost of a building, even though maintenance will be costly and fire hazard high, for they have the impression that a truly fire-safe structure will cost more than it really would. Education helps, but the crying need is for measures that will bring about the fire-safe age long before education, plus the increasing costs of combustible construction, would do the work.

Building codes that now permit frame construction should be modernized so as to compel the erection of structures that will better protect our natural, financial, and human resources. We can now build reasonably permanent and fire-safe homes at practically the cost of frame. There is no longer any economic justification for other types of construction. The log cabin age has passed. The fire-safe age—the Concrete Age—is at hand.

Why Hibernate?

Winter may be close at hand, but there is no need for the busy builder to go into an old-fashioned annual hibernation. With plenty of clothes to wear, plenty of fuel for the boiler, the heater, and the salamander on hand, a good supply of tarpaulins and straw to protect the work, and with plenty of that old ambition, there is no valid reason why concrete work should not be carried on successfully, and profitably, throughout all but a few of the coldest days of the year.

There are a multitude of excellent structures standing today that were put up at a reasonable cost during the coldest winters of the past,—buildings that are a standing credit to the contractor with the nerve to see it through. It's true, we admit, that no-one can put in concrete in the north during cold weather without taking real precautions to prevent freezing; but it is just as true, we will maintain, that anyone can do this sort of work if he only knows how. The whole secret lies in keeping the temperature of the job well above the freezing mark until the concrete has gained the required strength. Heat the materials, heat the water, cover the forms, shut out the weather, keep the heaters going, and the work will turn out all right. Savings in materials and labor frequently will be obtained, and a permanent organization of trained men be made available. The extra cost will be taken care of in extra profits, and the owner will be glad to collect his rents month sooner. Why emulate the bear, when you can bull the construction market and rake in the shekels?

Let's Get Together

In the course of editing a journal such as this, we frequently discover a lot of petty jealousies that affect the relationships between certain divisions of the field. These jealousies are usually unnecessary and certainly are not constructive. For instance, whenever we devote any space in our pages to the subject of cinder concrete products, we immediately get a protest from manufacturers of stone concrete products, taking us to task for presenting in our pages stories about this other type of products. And when we present stories of stone concrete products, then come protests from other types.

It seems to us that such protests are without basis. If one portion of the field is better represented in our pages than another, it is not because the publishers desire to devote more space to one portion of the field than another, but merely because certain manufacturers in the field hide their own lights under a bushel. We obtain no information purely out of thin air. Our pages are devoted to matters of fact, as presented by those at whose disposal the facts may be. When we find an idea in a certain direction that might be of considerable interest to other portions of our field, we lose no time in presenting such ideas to our readers, provided they merit publication. We would welcome similar stories from other manufacturers.

Concrete is a journal devoted to the technical development of the use of concrete, no matter what the use nor what the form. Everything is grist for our mill that is meat for our readers. The interests of the field are our interests, and we do our best to serve the interests of the field.

It is of the utmost importance to the field, and therefore of importance to us, that we all work together. There is too much to do to compete with other types of construction, when they overlap into the particular field that should be given to concrete, for us to be continually pulling at cross purposes.

For the good of the industry, let us all pull together, no matter what our interests may be.

What Happens When an Earthquake Tests Modern Construction

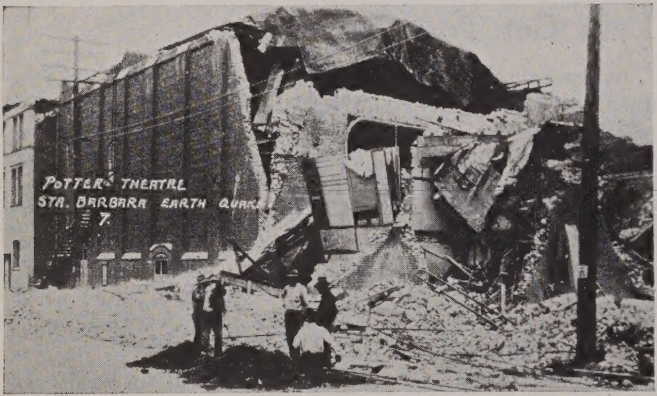


Fig. 7—Potter Theater, Santa Barbara, a brick structure of ordinary construction. The roof and the end of building including the stage and part of the proscenium arch were destroyed

Photo by courtesy of the Van Guilder System Concrete Buildings, Inc.

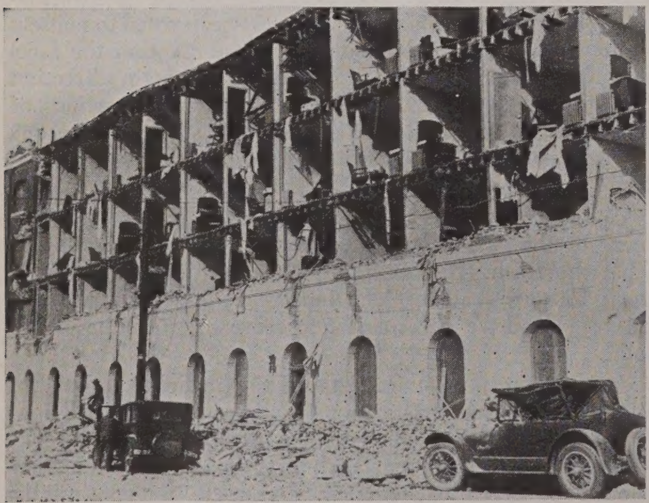


Fig. 3—The Hotel Californian on State St., Santa Barbara, after the earthquake. The result was the apparent shearing off of the side wall, leaving the bedrooms practically intact

Photo by Underwood & Underwood, New York City

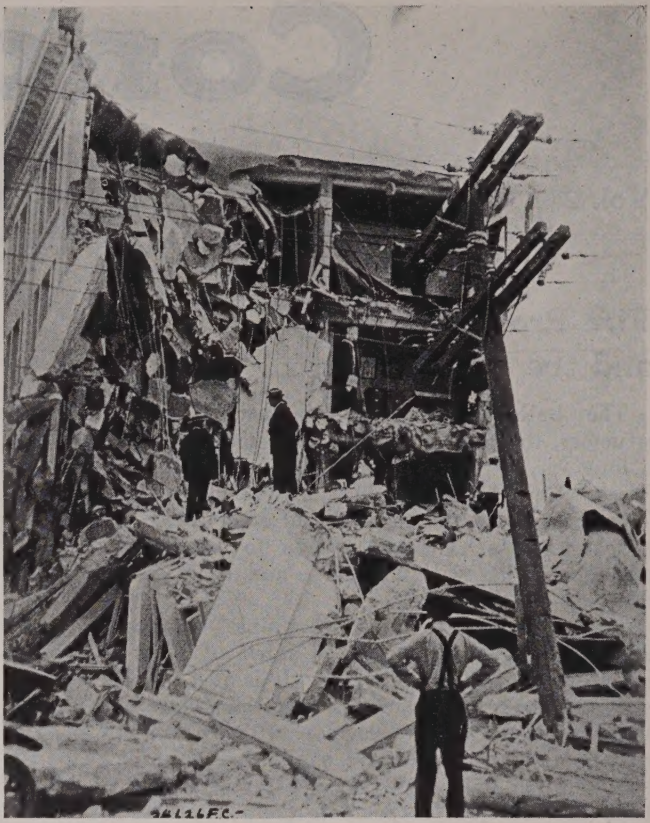


Fig. 1—The San Marcos Building in the business section of Santa Barbara. This building had a diagonal section cut off by the earthquake action

Photo by Underwood & Underwood, New York City

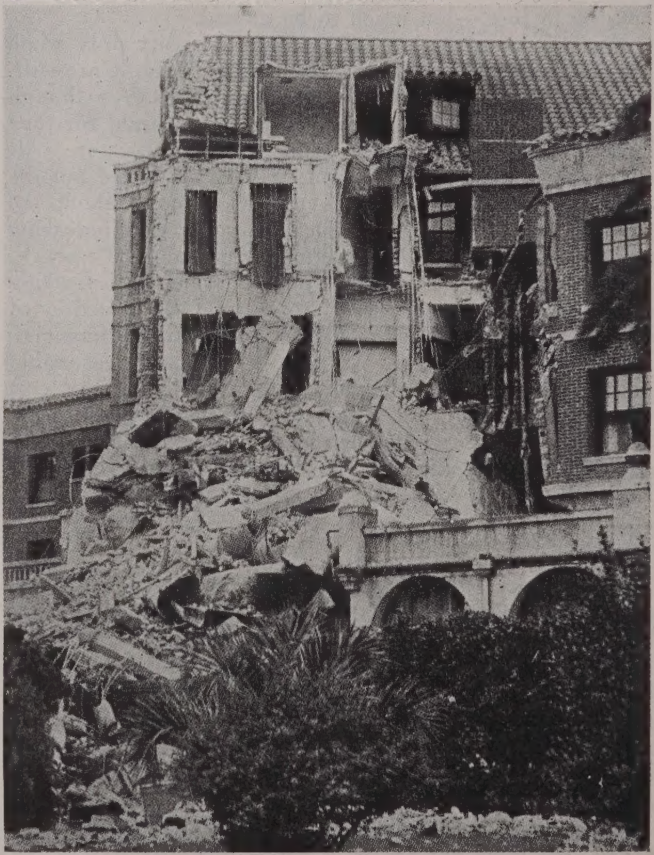


Fig. 2—The Arlington Hotel showing the destruction caused by a watertank filled with 60,000 gallons which crashed through the roof and to the ground

Lessons to Be Learned from Recent Earthquakes

Santa Barbara's recent earthquake and the various independent investigations that have followed it of its effects on the various kinds of buildings emphasize the importance of proper material and workmanship regardless of the type of construction, whether of reinforced concrete, solid masonry, frame or combinations of these various types. At some point in the earthquake zone a building of some particular construction may be seen standing practically undamaged, while other types were wrecked. In another case the conditions may be reversed as regards the materials used in construction of adjacent buildings, and a type of building similar to structures wrecked in the first case stands out as a monument to good workmanship.

To tell the story of the effect of this country's most recent earthquake on concrete construction would involve a summary of all the investigations into the buildings and their behavior during the disturbance, but various independent reports have been issued and much information has been made public which shed light upon this important subject.

Earthquake Action

A brief explanation of earthquake action is contained in an article by R. F. Moss, vice-president of the Truscon Steel Co. of Japan, Tokyo, recently published in the *Engineering News-Record.* An earthquake is described as consisting of "vibrations both horizontal and vertical in the earth's crust." These horizontal and vertical vibrations may occur simultaneously and the longitudinal vibrations may occur in several directions during the same earthquake, it is pointed out. "The amplitude, that is, the maximum horizontal movement in any direction may in the case of destructive earthquakes, be as much as 18 inches. It varies considerably for different localities during the same earthquake, and varies in the same locality according to the hardness of the earth's crust at any point —the amplitude, and therefore, the severity of the earthquake being generally greater in soft than in hard soil.

"The vertical movement and accelleration are generally from one-sixth to one-third as much as the horizontal, and seldom, if ever, greater than about one-tenth that due to gravity. The horizontal acceleration may, however, be as great as four-tenths of the acceleration caused by gravity. The really destructive portion of an earthquake seldom lasts longer than about 10 seconds."

Further, it is stated, inasmuch as the vertical part of the earthquake exerts a force of not more than one-tenth the force of gravity, it is clear that this part of the earthquake can not harm any properly designed building. "It is also clear that there can be no appreciable difference in the lifting of different parts of the same building by the vertical vibrations, because the earthquake wave length varies from 30 to 300 miles." The vertical vibrations are eliminated from further consideration.

Effect on Reinforced Concrete Buildings

The effect of the Santa Barbara earthquake on reinforced concrete buildings as given by a committee of engineers appointed by the California Common Brick Manufacturers' Association and allied interests is given as follows:

Santa Barbara has a large category of various types of reinforced concrete construction and demonstrated clearly that properly designed and constructed buildings of this material came through the catastrophe exceptionally well.

As an example of flat slab reinforced concrete construction, take the Latham's Fireproof Storage. This building is five stories high with reinforced concrete exterior walls. The concrete is of fair quality and the design apparently well conceived except for some details. The slight damage done to this building occurred at the exterior end walls where the proper consideration apparently was not given to bending in outside wall columns. As a whole the structure is a tribute to its type and the slight damage done can be repaired at a minor cost.

Another building of flat slab construction is a two story concrete frame building with brick filler walls, occupied by the Coast Wholesale Grocery Co. The exterior columns in this case were evidently designed for bending, with the result that there were no failures in any of the columns. However, due to shifting of combination footing and retaining wall, there was a slight separation of the columns from the base on the north side of the building. The entire brick parapet dropped off due to lack of anchorage. The brick filler walls stood very well except in a few instances and these failures were due primarily to lack of bond between the face brick and the brick backing and also between the brick and concrete frame.

In reference to the total or partial collapse of other concrete buildings such as the San Marcos Office Building, Arlington Hotel, the building occupied by the Barbara Top and Trimming Works, etc., we attribute these failures to flagrant violation of proper design, poor materials, poor workmanship or a combination of all three.

In reference to concrete structural frame with terra cotta tile filler walls, of which there are a considerable number, it is sufficient to take two examples quite similar in general character. The St. Francis Hospital failed quite seriously structurally, in the filler walls and in the partitions. General observation would indicate that the columns were slender and of insufficient size to properly take care of bending, although apparently sufficient for direct vertical loads in spite of the fact that concrete is of poor quality. In direct contrast to this failure there is the St. Vincent Orphanage, a building of similar design except that the columns seemed to be of larger proportions and of better materials and workmanship, the damage being confined to a few minor inconsequential cracks. That this building was subjected to severe earthquake strain is evidenced by the fact that portions of the heavy tile roof were shifted in sections. The moving of this tile roof has no connection with the structural stability of the building.

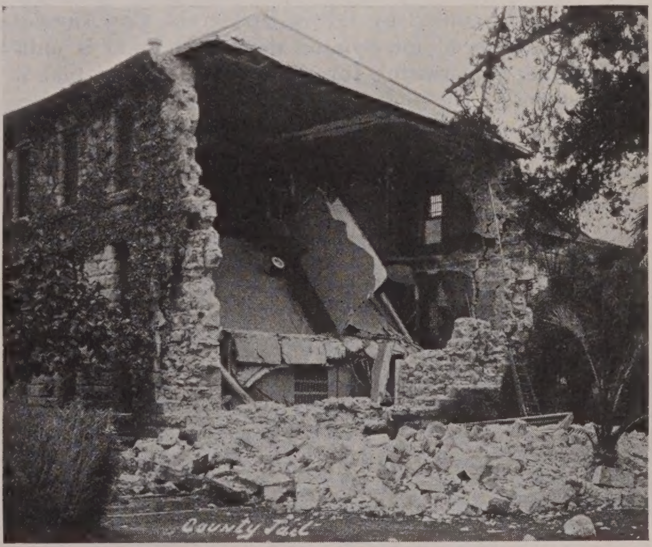


Fig. 8—The county jail, Santa Barbara, a stone structure, which was practically wrecked

Photo by courtesy of the Van Guilder System Concrete Buildings, Inc.

The committee consisting of H. J. Brunnier, J. G. Little, and T. Ronneberg, consulting engineers of San Francisco, who had been particularly active in building work in San Francisco immediately following and continuing since the disaster in 1906, were requested to make a detailed study and report, the association and allied interest being desirous of securing facts for the good of the building industry and building owners.

The above named committee of engineers included in its report: structural steel frame buildings; reinforced concrete buildings; brick buildings; terra cotta hollow tile bearing walls; street front walls of brick buildings; and parapet walls and chimneys, and drew the following general conclusion:

> All architects, engineers, contractors, building materials people and building owners should visit Santa Barbara immediately to see and study the effect of the recent earthquake. The destroyed buildings are an indictment against poor structural design, inferior material and careless workmanship. This is so self evident even to a layman that it needs no theoretical arguments because it is plainly and practically demonstrated by the fact that in the midst of the ruins there remain standing intact as a monument to skill and integrity, structural steel framing, reinforced concrete construction, brick buildings, terra cotta wall construction, and wood frame buildings.
>
> In every building damaged in the earthquake of Santa Barbara, the damage is due not to the kind of material used nor the type of construction attempted but to poor workmanship, inferior quality of materials, improper design or a combination of the three.
>
> For a number of years after the destruction of San Francisco in 1906, the phrase "Lest we forget" was the universal slogan and warning. But as time rolled on, the people have forgotten and through ignorance or selfishness, poor construction is creeping in. Let us revive the phrase "Lest we forget" and insist that all buildings be properly designed and carefully inspected and constructed with good materials, honest and careful workmanship.

Albert C. Martin, a member of a committee of Los Angeles engineers who made a survey of the Santa Barbara ruins, is quoted as stating in his report that "the Santa Barbara damage was 98 per cent due to poor design of structure and foundations, poor workmanship and poor materials."

To J. J. Backus, building inspector of the city of Los Angeles, is attributed the statement that most of the damage should be charged to poor construction, listing under this head the careless pouring of concrete, the use of too much lime and not enough cement in brick mortar, failure to use enough anchor rods and put them in properly, and the utilization of beach sand for mortar and concrete work. The latter objection, it is stated in *American Builder*, is also raised by Edwin Bergstrom, Los Angeles architect, who is of the opinion that beach sand is unfit for building construction for the primary reason that it is too smooth. The polishing of the sand by the action of incoming and outgoing tides causes it to lose the necessary sharpness to produce good mortar.

Another fault mentioned is the failure to keep brick and tile work wet for a sufficient length of time to let the binding material set thoroughly. The failure to use proper anchor rods to tie the brick store fronts is cited as one of the causes of failure in certain types of buildings. Anchor rods projecting through the front of the brick facing and having sizable washers or S-shaped anchors on the ends of the rods are advocated as capable of exercising the maximum tying power.

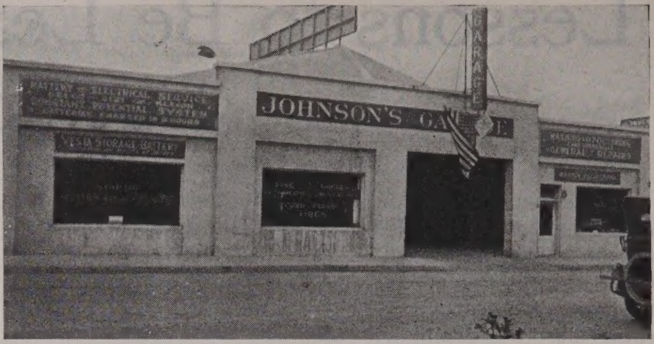


Fig. 4—Johnson's Garage after the earthquake. This building, having a roof span of 92 ft. without center supports, was practically undamaged

Photo by courtesy of the Van Guilder System Concrete Building, Inc., New York City

According to Mr. Bergstrom, builders in southern California are quite well agreed that whatever the construction may be if the building is properly designed and tied together in accordance with normal practice it should withstand the strain of earthquakes such as have been experienced in the United States.

One way advocated to fortify a building against earthquakes is "to build it so rigid that it will move as a unit when the ground moves." The bracing of buildings against side thrust by means of substantial dividing walls in both directions is recommended by Building Inspector Backus of Los Angeles.

The recommendations of Wilbur S. Sample, engineer for the George A. Fuller Co. of the Orient, who was upon the scene of the earthquake in Japan soon after it occurred in September, 1923, are included in the *Industrial Digest* in the two following paragraphs, and are considered as applicable to earthquake regions in general:

All foundations should be of friction piles capped with reinforced concrete, isolated pier spread footings or a solid concrete mat without piles; steel columns should be placed in straight lines in each direction so that at every panel there will be a maximum number of points of resistance and the sections of columns should be as wide as possible in each direction and should be connected at each floor by girders as deep as the requirements for headroom will permit. Both columns and girders should be latticed. In all cases where reinforced concrete is used the specification for the mixture should be made after

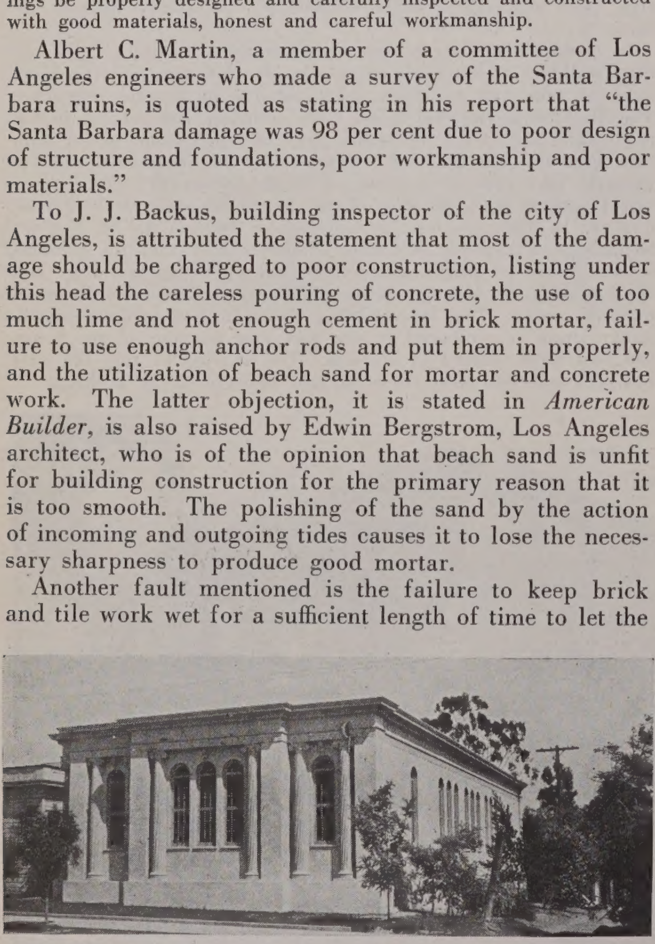


Fig. 6—Christian Science Sunday School Room, Santa Barbara, built with interlocking hollow concrete tile laid dry. This building was reported as undamaged by the earthquake

Photo by courtesy of the L. & B. Machinery Co., Santa Barbara

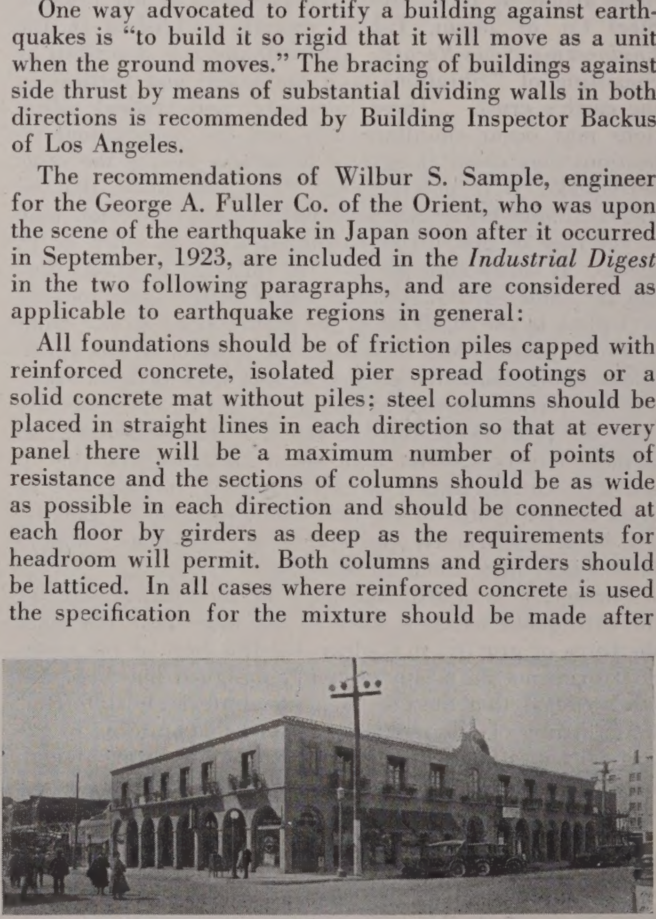


Fig. 5—Corner view of Carrillo Bldg., after the earthquake, which came through the shock as shown while some of the adjoining buildings were wrecked

Photo by courtesy of the Van Guilder System Concrete Buildings, Inc.

a study of the screen analysis of the coarse and the fine aggregates available for use.

He also advocates reinforced concrete for exterior piers around steel columns, for interior columns and connecting girders, for walls wherever possible between columns in the interior and around elevator shafts, vents, etc., and from basement to roof and from outside to outside walls. Avoid the use of brick or stone veneer for exterior facing, he adds, if possible using only stucco work or thin tiles, forming the outlines of projecting cornices, belt courses, etc., as largely as possible in reinforced concrete. If impracticable to use reinforced concrete partitions he advises metal lath on steel studs, solid brick, hollow brick and hollow clay tile in the order named. Lighting fixtures should be either indirect system flat against the ceiling or should have stiff suspension. If marble is to be attached to walls or columns use a minimum of marble slabs.

Special Types of Construction

Some types of buildings built according to special systems are reported as having stood the Santa Barbara earthquake shocks exceptionally well, but a note of warning should be sounded to the originators of these systems, for, as in the case of other types of construction, much depends upon the workmanship in carrying out the plans. Any system if not properly followed with careful workmanship is apt to share the fate of other buildings should the locality be subjected to further earthquake shock.

One of the special types of construction which are reported as withstanding the earthquake shocks is the Van Guilder system of construction which consists of two solid concrete walls anchored together but separated by a continuous sealed air space. Johnson's Garage on Haley Street, Santa Barbara, is of Van Guilder construction, 92 ft. by 190 ft. without center supports. The owners of this building reported that in spite of the fact that at the time the structure was being erected many builders expressed their opinion that the roof would not stay up under ordinary conditions, the only damage suffered at the time of the earthquake was due to the collapse of another building onto a part of the roof. The Carrillo Building, another of Santa Barbara's structures built by the Van Guilder system was also reported as practically undamaged while adjoining buildings were severely damaged. Whether these conditions are due to the type of construction or to the fact that proper workmanship and care were exercised in their construction, or a combination of these two factors, the Van Guilder system of concrete construction is stated by one of the engineers on a committee making a study of the effect of the earthquake on the different materials in use, to have stood the shock and come through in very good condition with a marked absence of visible cracks. The proper bonding together of the inner and outer shells that make up the wall section with metal ties adds to the rigidity of the whole structure.

Another special type of building that is reported to have stood the test of the earthquake is represented by the Christian Science Sunday School Building built of interlocking hollow concrete tile. This system originated by the L. & B. Machinery Co., Santa Barbara, involves the use of concrete tile with tongue and groove at the top, bottom and ends, tied together by steel rods extending from the top of the building to and hooked securely into the foundation. Concrete poured down the space bonds with the rods making a solid reinforced corner. Lateral rods are also placed at certain position in the walls such as over windows, doors, etc., where again concrete is poured into the openings in the tile making solid concrete lintels.

Each occurrence of earthquakes should bring to the attention of the owner as well as the builder the importance of sound construction, and in view of the possibility of recurrences of these shocks in certain sections of the country, the experts in the industry should be looked to in the design and construction of future buildings. There should be no slackening off in any of the factors that have been found essential in the construction of earthquakeproof buildings, regardless of the type of construction or the materials used.

The Deterioration of Concrete in Sea and Alkali Water

By O. L. GROVER, Bridge Engineer
U. S. Bureau of Public Roads

This subject is so important that it has been, and still is, being studied by many engineers and chemists interested either in maintaining old structures or constructing new ones, and in attempting to find improved ways of preventing loss of existing and future structures.

There are some instances of concrete which has stood the effects of salt water for hundreds of years. To the character of the cement used in them is apparently due their undamaged condition.

The damage to well made portland cement concrete begins at the surface and works gradually so that there is ample opportunity for inspection and repairs, if necessary, to keep the structure in use. The first breaks in concrete surfaces generally occur along construction joints in the tidal range with added tendency of loss at square corners, although in some cases decomposition or disintegration is said to occur well below the elevation of low water. The breaking of the surface and continued erosion are aided by any floating objects such as ice or timbers. No section of sea coast or part of the country having sulphate bearing water appears to be free from the injurious effects on concrete.

In bays and streams subject to tidal action but protected from violent waves the loss of section begins at about mean tide and thins out rapidly upward and downward leaving a flat V-shaped cavity along the sides and ends of walls.

In locations exposed to wave action a similar loss of section is noticeable but it is less regular in shape and extends to a greater depth.

Excerpts from an article in *American Highways*, published by the American Association of State Highway Officials.

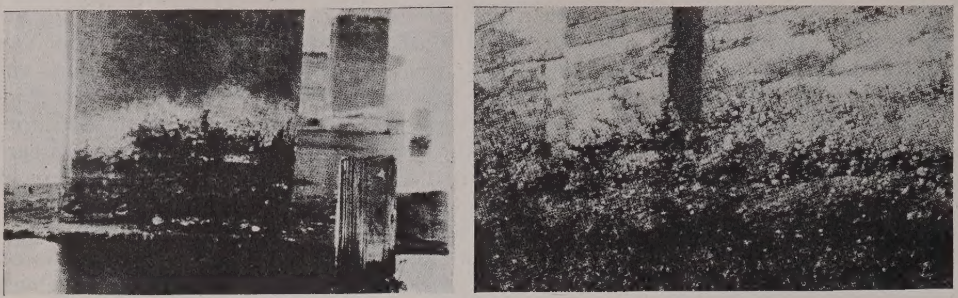


Fig. 1 (left)—Deterioration of concrete in alkali water, Wichita, Kans. Fig. 2 (right)—Foundation wall of building, navy yard, Boston, just before repairs were made. It shows the poor quality of the concrete and the extent of the erosion which occurred between high and low tide. This was most severe at construction seams

The presence of steel in reinforced concrete is frequently a contributing cause of spalling on account of insufficient concrete covering over the reinforcement and the presence of construction joints where the salt water comes into contact with the steel. In some cases the disintegration of concrete has started so early and proceeded so rapidly that the corrosion of the steel has followed only after the loss of concrete covering.

That many of the marine structures in which portland cement has been used will eventually be injured by sea water seems almost certain unless a durable, protective covering is placed around the portions in contact with sea water. A layer of portland cement mortar applied as a surface coat does not form a permanent protective cover.

Conclusions based on the good appearance of ordinary concrete construction during the first eight year period are likely to be found erroneous in later years. Dense concrete of 1:2:4 mix shows only small injury for the first eight to 10 years but may just then have reached an age when the outer surface is beginning to show breaks or unsoundness.

Complete protection has been obtained in the past by facing piers and abutments exposed to sea water with granite or other durable stone. Several bridges have recently been constructed both in sea water and alkali water where the best obtainable grade of paving brick was used for pier facing and this construction seems likely to be successful. Covering with waterproofing or an integral waterproofing may be developed so as to be successful in time although it is now largely in the experimental state and may require further experimentation and trial to develop and test out methods. Increased life in an undamaged condition is to be expected by the use of effective waterproofing.

There has been developed in France a cement claimed to be stable in sea water. That such a cement may be available in a few years seems likely, although it may be considerably more expensive than portland cement. The use of a more durable cement than portland would probably not overcome the necessity for the best materials and workmanship for permanency.

From an inspection of existing structures and from the reports of engineers who have examined many of them, the following points are selected as representing the majority opinion on the essentials for obtaining good durability but not full permanence.

Requirements for concrete in order to compare favorably in durability with other materials:

1. Hard, clean and durable aggregates.
2. Well graded aggregates shall be used so as to have the maximum density.
3. Fresh, clean mixing water and the amount carefully controlled so that the concrete will have the greatest possible impermeability.
4. Use only an approved cement, with a preference for a cement proven by experience or tests to be resistant to damage by sulphate bearing water.
5. Preferably use a mixture of 1:1¾:3½ proportion, but not leaner than 1:2:4.
6. Minimum mixing time 2 minutes.
7. Preference to be given to precast sections, and precautions taken that no cracking or injury is done during the placing. Precast piles shall be very carefully handled and driven to avoid cracking.
8. Allow the concrete to become thoroughly hard and precast members to cure at least 30 days, and preferably 60 days, before exposure to sea water. One-half of the curing time shall be in a moist condition and one-half in dry air.
9. No construction joints shall be permitted in the region between an elevation 2 ft. below water to 2 ft. above high water.
10. Arrange the structure with a minimum number of construction joints and cast each unit in one continuous operation.
11. Avoid the use of steel reinforcement by choosing plain types so far as practicable.
12. Steel reinforcement shall not be stored in the open air prior to use but shall be protected from the corrosive effects of salt atmosphere by storage in a covered, dry shed.
13. Reinforcement, if used, shall be given as much protective covering of concrete as practicable with a minimum of 3 inches from center of main bars to the concrete surface for piling.
14. Preferably use round sections and avoid square corners on piles, piers or abutments.
15. It is recommended that an approved integral waterproofing, which does not reduce the strength materially, be used.

A committee on Marine Piling Investigations of the National Research Council has studied the history of the subject and the results of their study were published in the 1924 Trans. Am. Soc. C. E., Vol. 87, page 204, by Wm. G. Atwood and A. A. Johnson, together with a bibliography and extended discussion to which the reader is referred.

Good Strength Found in Old Concrete

In razing the 27-year-old bulkhead wall to make way for the construction of the Delaware River Bridge, the engineers sent pieces of the old concrete to the Structural Materials Research Laboratory, Chicago, for compression tests. It is reported that the samples were found to average 5780 pounds per square inch, while that portion taken from below the tide level showed average strengths of 6280 pounds per square inch.

The Design of Cement Concrete Pavements

Forces to Be Resisted by a Concrete Pavement

By A. T. GOLDBECK
Chief, Division of Tests, U. S. Bureau of Public Roads

(Concluded from CONCRETE, September, 1925)

It has already been stated that the strength of the corner depends in a large measure upon the actual thickness of cross-section at the corner and this varies, depending upon the shape of cross-section of the slab finally adopted. In Fig. 15 is shown a study of the relative strengths of several cross-section designs on the basis of the calculated section modulus at the corner. Comparison is also made of the concrete required for these various designs. It will be seen that there is a very great difference in the edge strength, depending upon the design and that with a given amount of concrete it is quite possible to obtain greatly different strengths. A complete study of this kind will show the best cross-section to use considering both strength and economy. The section moduli were calculated for sections 2, 3 and 4 ft. from the corner, measured along the edge of the pavement, for corner cracking ordinarily occurs within this zone.

Reinforcing Steel

The subject of reinforcing steel for concrete highways is yet in an unsettled condition. At the present time a special investigation is under way in the field under the direction of the Highway Advisory Board of the National Research Council in an attempt to settle definitely the degree of benefit to be obtained from the use of steel. Theoretically it can be shown that steel does add to the resistance to cracking of the concrete under load, provided it is so placed as to receive tensile stress. There is one point which is frequently overlooked, however, in connection with the extra strength provided in roads by reinforcing steel. If it is assumed that the modulus of elasticity of steel and concrete are 30,000,000 and 3,000,000, respectively, and that the bond resistance of the steel reinforcing is unbroken, then if the concrete is stressed to 600 lb. per square inch, at which stress a crack ordinarily occurs, the steel is only stressed to 6000 lb. In reinforced concrete building construction a stress in the steel of 16,000 to 18,000 lb. is permissible. It is thus seen that the full strength of the steel is incapable of being used for preventing the cracking of concrete highways. Because of the low unit stress possible in the steel at the point of failure of the concrete in tension, it is very readily apparent why the steel cannot add very much to the resisting moment of the concrete with the small amounts of steel ordinarily used in reinforced concrete pavements. This is not an argument against the use of steel, for it is quite possible that, although the concrete might be cracked under loads, the steel will hold it together sufficiently to prevent further separation and no particular maintenance might be necessary.

Arlington Tests

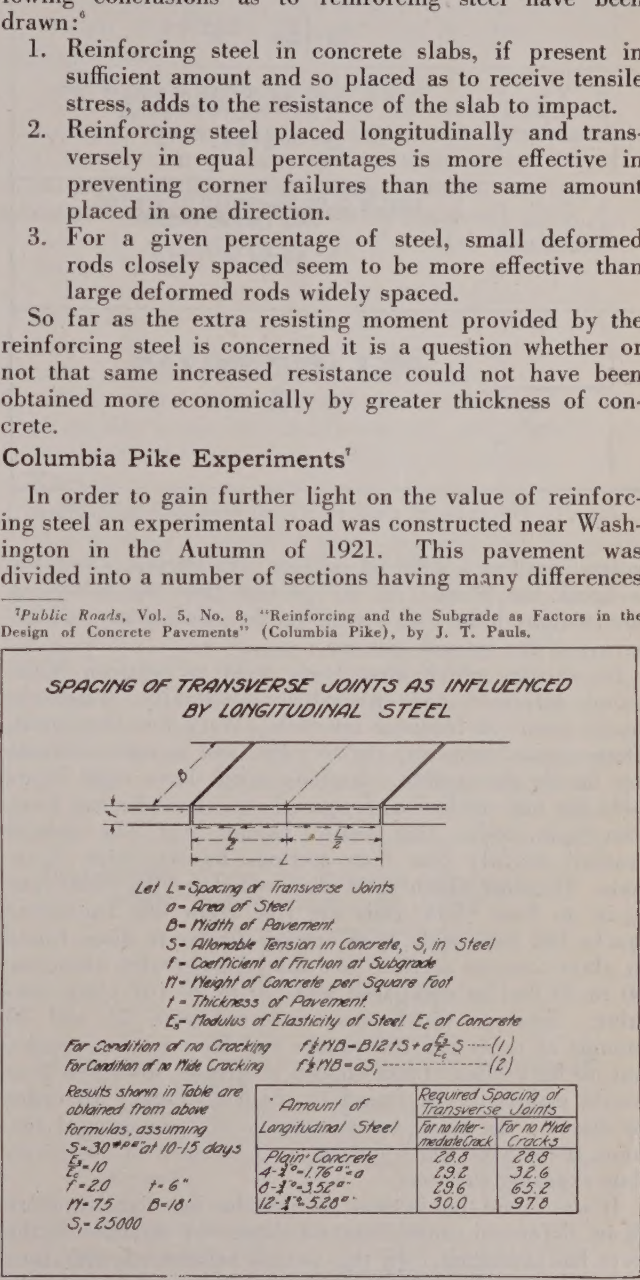
Tests made at Arlington by applying load with an impact machine exactly simulating truck impact will throw light on the question of the probable value of steel for adding to slab strength, especially at the corner. These tests have been discussed in detail elsewhere and the following conclusions as to reinforcing steel have been drawn:[6]

1. Reinforcing steel in concrete slabs, if present in sufficient amount and so placed as to receive tensile stress, adds to the resistance of the slab to impact.
2. Reinforcing steel placed longitudinally and transversely in equal percentages is more effective in preventing corner failures than the same amount placed in one direction.
3. For a given percentage of steel, small deformed rods closely spaced seem to be more effective than large deformed rods widely spaced.

So far as the extra resisting moment provided by the reinforcing steel is concerned it is a question whether or not that same increased resistance could not have been obtained more economically by greater thickness of concrete.

Columbia Pike Experiments[7]

In order to gain further light on the value of reinforcing steel an experimental road was constructed near Washington in the Autumn of 1921. This pavement was divided into a number of sections having many differences



SPACING OF TRANSVERSE JOINTS AS INFLUENCED BY LONGITUDINAL STEEL

Let L = Spacing of Transverse Joints
a = Area of Steel
B = Width of Pavement
S = Allowable Tension in Concrete, S_1 in Steel
f = Coefficient of Friction at Subgrade
W = Weight of Concrete per Square Foot
t = Thickness of Pavement
E_s = Modulus of Elasticity of Steel. E_c of Concrete

For Condition of no Cracking $f\frac{1}{2}WB = B12tS + a\frac{E_s}{E_c}S$ ----(1)
For Condition of no Wide Cracking $f\frac{1}{2}WB = aS_1$ ----(2)

Results shown in Table are obtained from above formulas, assuming
$S = 30$ #P" at 10-15 days
$\frac{E_s}{E_c} = 10$
$f = 2.0$ $t = 6''$
$W = 75$ $B = 18'$
$S_1 = 25000$

Amount of Longitudinal Steel	Required Spacing of Transverse Joints	
	For no Intermediate Crack	For no Wide Cracks
Plain Concrete	28.8	28.8
4-¾″°-1.76□″=a	29.2	32.6
8-¾″°-3.52□″	29.6	65.2
12-¾″°-5.28□″	30.0	97.8

Fig. 16—Spacing of transverse joints as influenced by longitudinal steel

in detail design. These sections in general were not shorter than 200 feet in length, and were separated by transverse expansion joints. It will be impossible to consider this experiment in detail, but several of the sections are interesting because of their different behavior with different percentages of longitudinal reinforcing steel. In all cases the steel was placed with sufficient overlapping so that in effect it was continuous throughout the entire length of a 200-foot section. No attempt was made to break the bond. At the present time the following observations hold with regard to the appearance and behavior of the several sections.

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[6] *Public Roads*, Vol. 5, No. 2, "Impact Tests on Concrete Pavement Slabs," by L. W. Teller.

[7] *Public Roads*, Vol. 5, No. 8, "Reinforcing and the Subgrade as Factors in the Design of Concrete Pavements" (Columbia Pike), by J. T. Pauls.

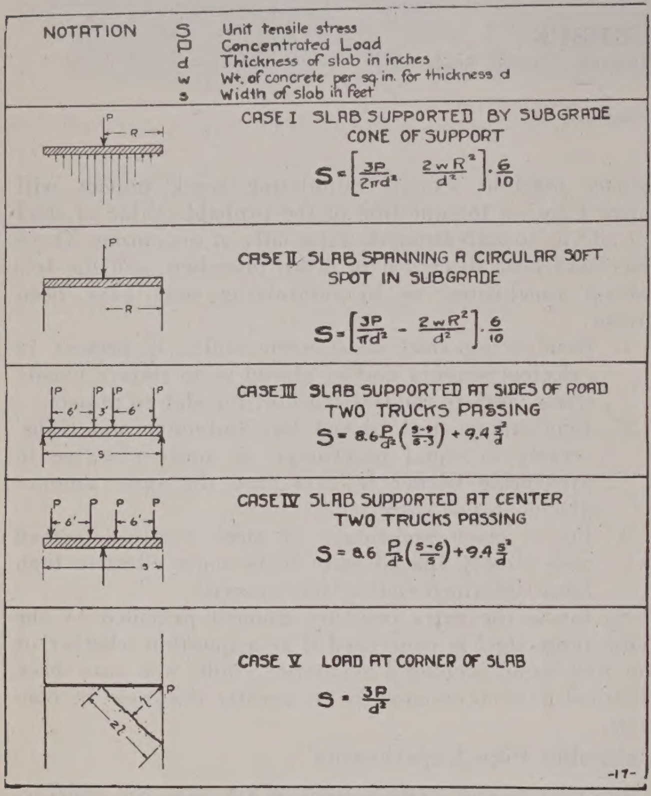
NOTATION
S Unit tensile stress
P Concentrated Load
d Thickness of slab in inches
w Wt. of concrete per sq. in. for thickness d
s Width of slab in feet
CASE I SLAB SUPPORTED BY SUBGRADE CONE OF SUPPORT
P
R
$S = \left[\frac{3P}{2\pi d^2} \quad \frac{2wR^2}{d^2}\right] \cdot \frac{6}{10}$
CASE II SLAB SPANNING A CIRCULAR SOFT SPOT IN SUBGRADE
P
R
$S = \left[\frac{3P}{\pi d^2} - \frac{2wR^2}{d^2}\right] \cdot \frac{6}{10}$
CASE III SLAB SUPPORTED AT SIDES OF ROAD TWO TRUCKS PASSING
P P P P
6' 3' 6'
s
$S = 8.6\frac{P}{d^2}\left(\frac{s-9}{s-3}\right) + 9.4\frac{s^2}{d}$
CASE IV SLAB SUPPORTED AT CENTER TWO TRUCKS PASSING
P P P P
6' 6'
s
$S = 8.6\frac{P}{d^2}\left(\frac{s-6}{s}\right) + 9.4\frac{s^2}{d}$
CASE V LOAD AT CORNER OF SLAB
P
2l
l
$S = \frac{3P}{d^2}$
-17-

Fig. 17—Thickness of slabs to prevent longitudinal cracking

In sections which have from eight to fourteen ¾-in. round deformed rods placed longitudinally, transverse cracks occur at frequent intervals a very few feet apart. These cracks, however, are very fine and in some sections are barely discernible. Sections which have eight ¾-in. rods are not cracked as frequently as those having fourteen ¾-in. rods. One section having four 1-in. rods is cracked slightly less than sections having eight ¾-in. rods. Sections which have reinforcing varying from four ¾-in. to four ½-in. rods are free from fine transverse cracks but have wide open cracks, similar to those found in plain concrete sections but spaced at greater distances, 60 to 70 feet as compared with 40 to 50 for plain concrete. Sections which are reinforced with 25 and 50 pounds of mesh per 100 square feet have no fine cracks, but do have open cracks spaced at greater distances than would ordinarily be found in plain concrete. In order to discover the cause for the action of these several sections the cracks were opened in a number of instances, thus exposing the steel.

It was found that in those sections having eight or more ¾-in. deformed round bars, no change in diameter of the bars had occurred. In the section reinforced with four 1-in. bars, slight reductions in diameter were found. In the section having four ¾-in. bars the diameter was reduced to ⅝-in. In sections having eight ½-in. rods the diameter has been reduced to approximately ⅜-in., while in still another section only four ½-in. bars, the bars had completely broken with a reduction in diameter to about ¼-in. In sections reinforced with mesh to the extent of 25 and 50 pounds per 100 square feet, the mesh was completely broken at the cracks. From these sections it is strongly indicated: (1) That longitudinal steel up to a certain amount does increase the spacing of the transverse cracks and these cracks will open on contraction; (2) that longitudinal steel above this amount might produce fine transverse cracks, spaced in some cases only a few feet apart.

Spacing of Transverse Joints

It should be remembered that in the above sections the transverse joints were spaced 200 feet apart, and it is not to be inferred that the same behavior, with regard to cracking and breaking of the reinforcing steel, would be found with different spacing of transverse expansion joints. For instance, if the transverse joints are spaced closely enough together it would be quite possible for the combined strength of the concrete and steel in tension at the mid-section to overcome the total frictional resistance between that section and each transverse joint. In this case notwithstanding conditions making for high contraction, the slab would slide over the sub-grade with no failure at the center. The analysis in Fig. 16 should furnish means for adjusting the percentage of longitudinal reinforcing steel and the spacing of transverse joints in such a manner that no intermediate cracking or at least no wide open cracking is liable to occur. Apparently the choice of the amount of steel must rest on the question of the economy resulting from its use. By using a large amount the number of transverse joints may be decreased. If no joints are used the number and width of cracks will vary depending in part on the amount of longitudinal steel and consequently the maintenance expense will vary. If the extra cost of the steel is compensated for by decreased yearly cost of the surfacing, the use of steel is economical. For the present no adequate data seem to be available on this point and it is hoped the present investigation of the Highway Advisory Board of the National Research Council will develop some useful information.

The Longitudinal Joint

It has been pointed out that under equal temperatures at the edge and bottom of the slab and unequal moisture content both might lead to the curling up of the slab from the sub-grade. Changes which occur in the sub-grade itself such as undue shrinkage at the sides or heaving at the center due to frost action might also lead to non-uniform support. It is quite evident that there are often conditions under which the pavement might have good support at the center with very little at the edges or the reverse might be true, and under these conditions heavy trucks passing one another will produce very high bending stress. The analysis in Fig. 17 gives two cases, Cases III and IV of this sort. By substituting the proper values it may be shown that the thickness of an 18-foot slab at the center which will just break under two passing 5-ton trucks is approximately 12 inches.

From this calculation it is quite evident that it would be highly uneconomical to attempt to design a slab of full width of sufficient thickness to prevent longitudinal cracking where conditions exist such as bad sub-grades or deep frost action making for high vertical movement. A longitudinal crack is to be avoided because of its tendency to form diagonal cracks extending to the edge of the pavement with the production of weak corners. This is prevented by the use of a center longitudinal joint. When a center longitudinal joint is used, however, efficient means must be provided so that the load will be transferred across the joint, making it possible for each corner to support its share of the load. The use of tongue-and-groove construction has proven successful for this purpose. In the far west heavy dowel construction is used because of the extremely large amount of vertical movement between the center and the sides of the road. It is desirable to prevent the center joint from spreading and in Fig. 18 are shown calculations for the amount of steel necessary for this purpose. The bars should be embedded at least 40 times their diameter to insure sufficient bond.

Wear Resistance

The design of concrete pavements would not be complete without some mention of the wearing resistance to be expected from the concrete. It is felt that high strength of concrete is not the only property which is important, for the expansion and contraction due to moisture and drying out and also the repeated action of frost are all factors to be contended with. Deneseness of mix and low absorption are very much to be desired. It is also important that there be high resistance to wear, especially in localities where tire chains are used. Recently an elaborate test was completed by the Bureau of Public Roads at Arlington to study the effect of different aggregates on the wearing properties of concrete. These tests have been published in detail[8] but I wish to quote here the conclusions which have been reached. It is to be remembered that these conclusions deal entirely with the resistance of the concrete to abrasion.

From the results obtained the following conclusions are made:

> That the rate of wear of stone concrete is, in general, not affected by the coarse aggregate, provided the coarse aggregate is equal or superior to the mortar matrix in resistance to wear.
>
> That excessive wear will result from the use of very soft stone as coarse aggregate even though used in conjunction with a mortar of satisfactory quality. From the results of these comparative tests it would appear that stone with a percentage of wear over seven should not be used in concrete road construction.
>
> That gravel concrete, in general, is at least as satisfactory from the standpoint of wear as stone concrete.
>
> That gravels consisting essentially of siliceous materials are superior as regards both the amount and uniformity of wear to those containing a preponderance of calcareous fragments.
>
> That gravels consisting of rounded particles are as satisfactory from the standpoint of wear as those consisting either wholly or in part of angular or crushed fragments.
>
> That small amounts of shale occurring in the coarse aggregate will cause both excessive and uneven wear.
>
> That the modified abrasion test for gravel in its present form is not an indication of the wear-resisting properties of coarse aggregates. It is suggested that if the severe impact action of the steel balls were decreased much more indicative results would be secured.
>
> That blast furnace slags should prove satisfactory for use in concrete pavements provided the proportion of light, porous slag is so controlled that the weight per cubic foot will be at least 70 pounds.
>
> That the presence of large amounts of light, porous fragments in blast furnace slag will cause excessive wear.
>
> That somewhat better results are secured by the use of the smaller sizes of slag.
>
> That slag or stone screenings are, in general, unsatisfactory as substitutes for natural sand as fine aggregates in concrete road construction.
>
> That the copper and lead smelter slags used in these tests would make satisfactory aggregates for concrete road construction from the standpoint of wear.
>
> That coarse sands, other things being equal, show greater resistance to wear than fine sands.
>
> That the so-called "tensile-strength-ratio" test is no indication of the wear-resisting properties of concrete made with these sands.
>
> That the Talbot-Jones wear test is not, in general, an indication of the wear which takes place under traffic.
>
> That neither the crushing nor the transverse strength of concrete is a measure of its wear-resisting properties.
>
> That the addition of hydrated lime in the proportion used in these tests does not affect the wear-resisting properties of concrete.
>
> That so far as resistance to wear alone is concerned, increasing the cement content beyond a cement-sand ratio of 1:2 does not materially affect the concrete. Leaner mixes on the other hand show marked increase in wear.
>
> That unusual precautions should be taken in using mine chats or other similar harsh-working materials, so as to increase workability to a maximum and thus make possible a smoother surface finish.
>
> That, other things being equal, either an excessively dry or an excessively wet mix will show less resistance to wear than concrete of medium consistency.

Conclusion

In conclusion it must be quite apparent that the methods now employed for the design of concrete pavements are not entirely rational but at the same time a surprising advance has been made in our ideas on design within the past few years through the application of intensive highway research. It is undoubtedly a fact that we can now design a pavement with almost entire certainty of its proving thoroughly capable of carrying the loads upon which the design was based. This was utterly impossible just a few years ago and the gratifying feature of the more rational methods is that they result not only in stronger but also in much more economical pavements.

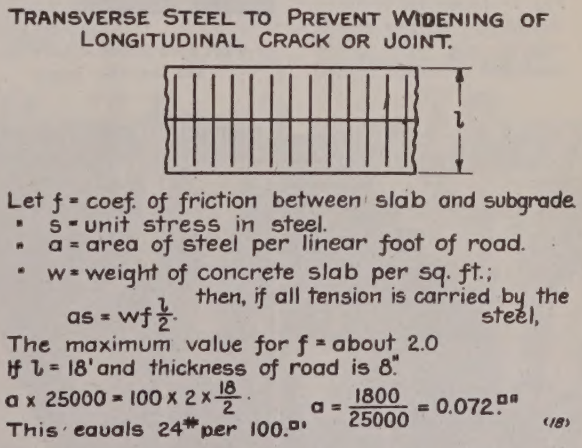
TRANSVERSE STEEL TO PREVENT WIDENING OF LONGITUDINAL CRACK OR JOINT.
l
Let f = coef. of friction between slab and subgrade.
" s = unit stress in steel.
" a = area of steel per linear foot of road.
" w = weight of concrete slab per sq. ft.;
then, if all tension is carried by the steel,
$as = wf\frac{l}{2}$.
The maximum value for f = about 2.0
If l = 18' and thickness of road is 8"
$a \times 25000 = 100 \times 2 \times \frac{18}{2}$.
$a = \frac{1800}{25000} = 0.072$ □"
This eauals 24# per 100.□'
(18)

Fig. 18—Transverse steel to prevent spreading of longitudinal joint

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[8] *Public Roads*, Vol. 5, No. 3, "Wear of Concrete Pavement Tested," by F. H. Jackson.

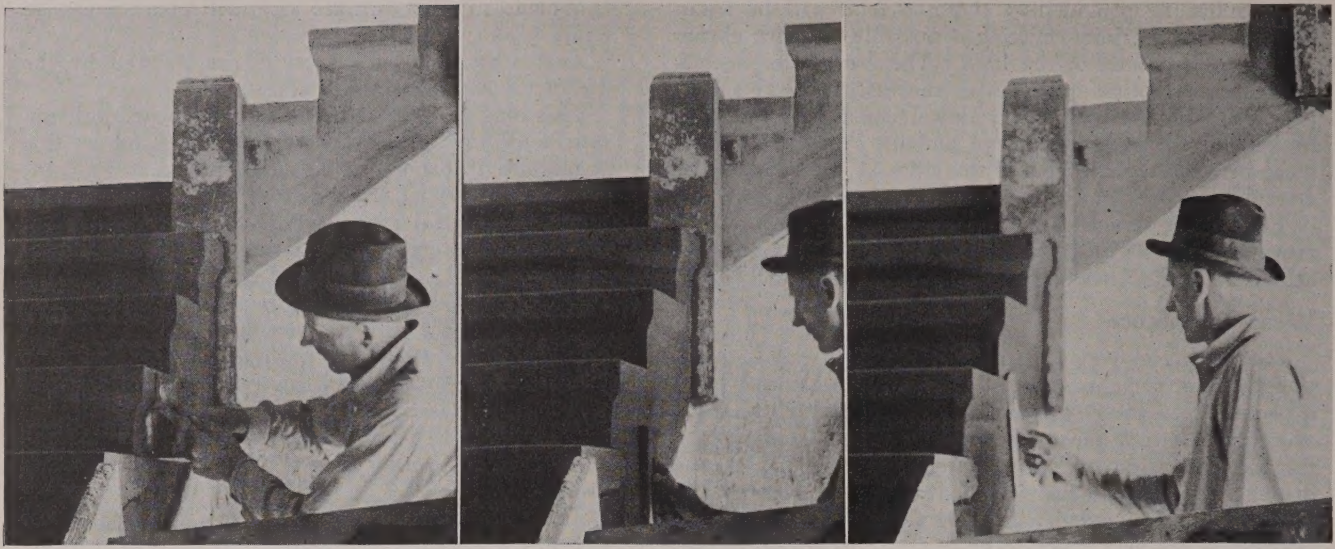
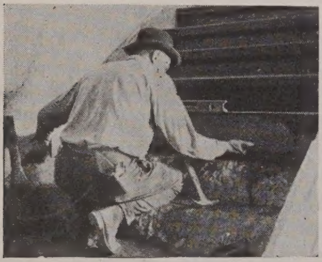


Fig. 5—Three distinct operations in stair finishing, where any but good workmanship is bound to show

"Twists of the Wrist" in Cement Finishing

The materials may be good, the tools the best adapted to the work in hand and the specifications may have been most carefully drawn—after all, there is the human element. It is, in the long run, on a thousand and one jobs, the man using the materials, the tools and the specifications, who makes a good job or a poor one.

There is always a kind of a thrill in seeing a man on the job in whose deft movements there is revealed a sure mastery of that job. Right away you know that this man is no dub.



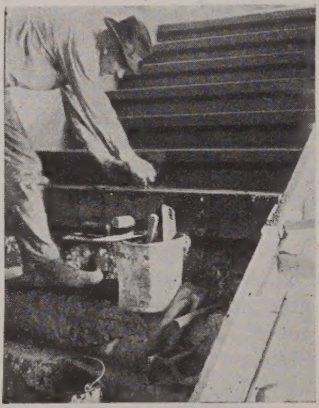
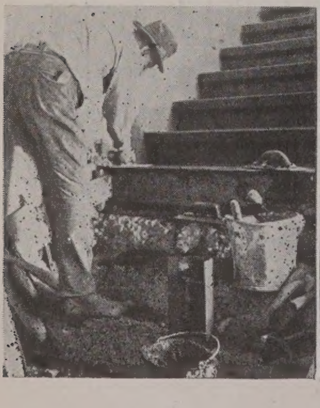


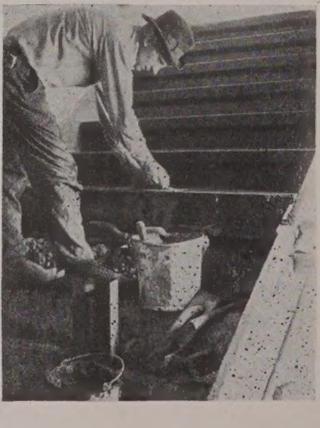
Fig. 1—Getting it level

Fig. 2—Finishing the face of a riser where the nosing makes it ticklish

Fig. 3—Joints and recesses, inside and outside angles, require not only several tools but an expert in their use

Fig. 4—Putting a hard finish on the tread





This magazine has been very glad on a number of occasions to direct particular attention—not to the job, the finished work, the building complete in which the individual is frequently lost, but to some man on some part of the work, under the twists of whose wrists the thing was made possible. The dignity of overalls is here apparent although so frequently forgotten. If the dignity of overalls were more often especially apparent and their wearer given his just due, we might hope for a more general return of that pride of craft which the construction field so much needs.

Each one of the pictures shows Ole Foshang. He was born in Norway in 1881 and came to the United States in 1908. He was trained as a mason in the old country by his father and when he came to this country immediately sought a place among the building trades. That place, in spite of the skill he had already acquired, was at first as a laborer, until he had learned something of the English language.

In 1916 he entered the employ of the Kalman Floor Co., Chicago, as a cement finisher but his skill at that work was so soon apparent that he was almost immediately put on special jobs—cove base, stair work and the like where the ordinary mechanic so soon makes a botch of it.

Foshang has been with the Kalman company ever since, most of the time as a finishing foreman but from choice he personally does all the ticklish, intricate jobs that come in his jurisdiction. He has a strong sense of loyalty to his task. The kind of work which Foshang is shown doing in the accompanying pictures requires not only a thorough knowledge of cement finishing itself but of general mechanics because on all such jobs the mechanic at least looks after the making of his own molds and forms. It is the kind of work that you can't find adequately described in a text. It has to be learned by seeing and doing and if a man likes that sort of thing he gets to have a feel of the material under his tools which is far more important than many paragraphs of specifications. The pictures were taken on a stair job for the Blue Valley Creamery, Chicago.

Bringing On the Fire-Safe Age

The Construction Industry Is Waking Up to Find Concrete the Truly Fire-Safe Material for All Structures

National Fire-Prevention Week, October 4 to 10, is to go a long way to crystallize the rapidly growing popularity of concrete as the material that will make our offices, our shops, our schools, our churches, our hospitals, and our homes truly safe from the Red Menace of fire. The general public is being educated to the point where concrete is generally favored when fire-safe buildings, and safety-giving highways, are to be provided. The education of the public, growing apace, is making it more than ever necessary for architects, engineers, and constructors to be prepared for that class of construction. People are being told the facts about this great kind of construction; how it will give them protection against fire, against tornado, against earthquake, and against the ravages of time. They are learning that permanent construction may be obtained at a first cost that in many parts of the country is hardly higher than frame, and that maintenance costs on such a building will be sufficiently low to more than cancel the additional first cost within the first five years. They are learning the benefits of lower property losses, of lower loss of life, of lower loss of business, and of the many other real benefits of fire-safe construction. This new knowledge, once it has firmly taken root in the popular mind, will go a long way toward reducing our present five dollar per capita annual fire loss to a figure that will be more in line with the less-than-a-dollar figure obtaining in Great Britain. The daily and weekly papers everywhere are taking an active part in the campaign. They are running editorial matter during the week that will sell the idea of better construction, and are running advertisements dwelling upon the merits of concrete buildings and structures of other types.

Local Demonstrations

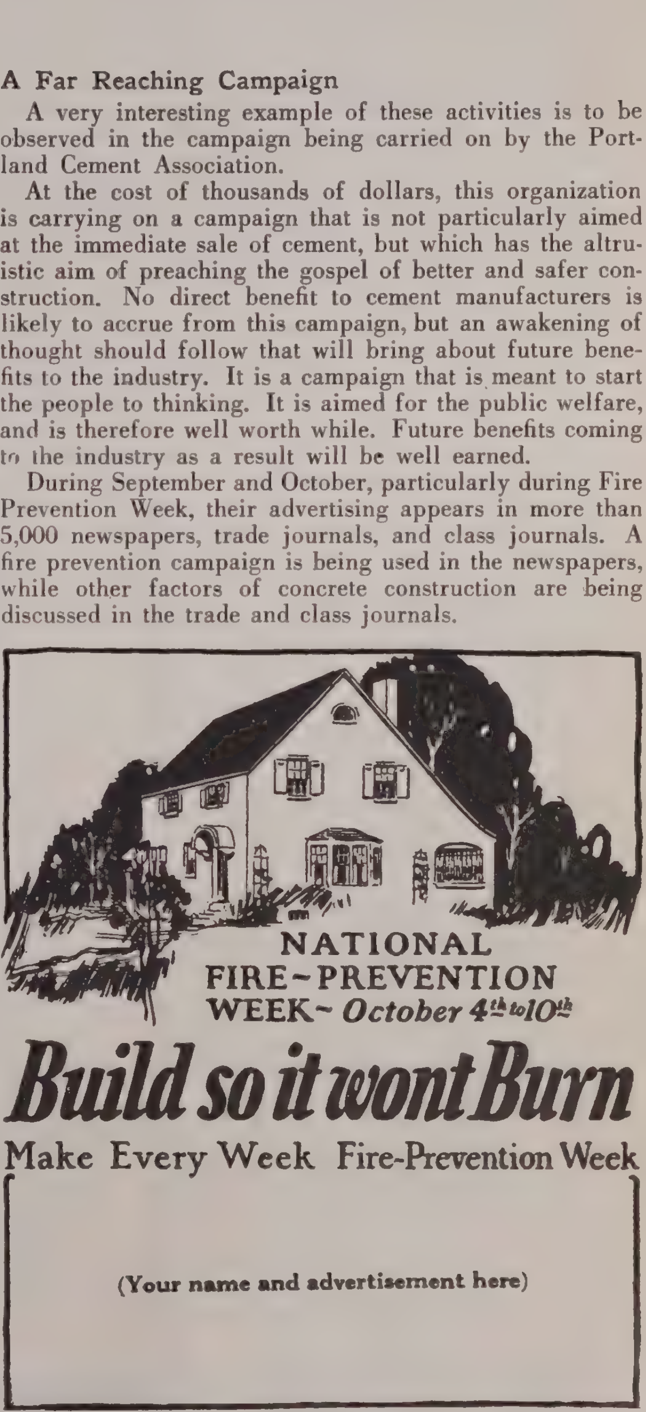
Local committees are staging demonstrations of different kinds, arranging programs for meetings at which authorities will discuss fire-preventative measures with the public, and all sorts of things are being done to bring the people to a great realization of their part in the campaign against the great waste caused by fire. Fire-resistive construction to guard against future loss is being kept in the foreground. The central idea of a modification of existing building codes is being heavily stressed. Legislation that would prevent further construction of combustible buildings is being advocated on every hand. A campaign to demonstrate the true economies of fire-safe construction is being carried on. Everything that can be done to sell the public on the idea that our annual fire losses are too great, far greater than the losses in any other civilized nation, is being done, and the process of education includes exposition of methods for reducing the great losses.

A Far Reaching Campaign

A very interesting example of these activities is to be observed in the campaign being carried on by the Portland Cement Association.

At the cost of thousands of dollars, this organization is carrying on a campaign that is not particularly aimed at the immediate sale of cement, but which has the altruistic aim of preaching the gospel of better and safer construction. No direct benefit to cement manufacturers is likely to accrue from this campaign, but an awakening of thought should follow that will bring about future benefits to the industry. It is a campaign that is meant to start the people to thinking. It is aimed for the public welfare, and is therefore well worth while. Future benefits coming to the industry as a result will be well earned.

During September and October, particularly during Fire Prevention Week, their advertising appears in more than 5,000 newspapers, trade journals, and class journals. A fire prevention campaign is being used in the newspapers, while other factors of concrete construction are being discussed in the trade and class journals.


NATIONAL
FIRE~PREVENTION
WEEK~ October 4th to 10th
Build so it wont Burn
Make Every Week Fire-Prevention Week
(Your name and advertisement here)

The suggested advertisement for concrete products manufacturers

While the campaigns of other interested organizations are more of a sporadic nature, the Portland Cement Association carries on its campaign the year round. The campaign at this time, however, is being tied in more than ever to fire prevention week.

Special Pages

Not only are the usual advertisements, such as those reproduced here, being placed in space averaging two columns by 9 in., but special fire prevention pages are being provided for use in many newspapers. Most of the space on the page is devoted to small advertisements inserted and paid for by local contractors, architects, material dealers, material manufacturers, plumbing supply dealers, electrical wiring contractors, and other local houses doing business in the local building industry. These advertisements have been prepared on general lines, but are intended more as a guide than as a regular copy service. Each advertisement is aimed to tie in with fire prevention week and show the public what each of the local advertisers is prepared to do in the way of the construction of fire-safe buildings. Letters have been sent to all concrete products manufacturers of record suggesting that they advertise during fire prevention week in such a way as to take advantage of the national campaign, preferably in the same papers that carry the Association advertising.

Three of the newspaper advertisements, reproduced on these pages, deal with fire-safe schools, fire-safe moving fire-safe structures that will eventually replace the firetraps hitherto in use.

Then there is the suggested advertisement for concrete products manufacturers, featuring National Fire Preven-
picture theatres, and fire-safe hotels. The message of fire-safety and concrete is brought home effectively in each of them, and is framed in such a way that citizens will feel the necessity for action, in order that the community in which they live may be able to boast of its splendid tion Week, and providing room for the manufacturer's copy, designed to be used in the home town paper wherever the manufacturer may be.

Special Information

The strength of this advertising campaign depends mainly on the facts which are being furnished to publishers, by means of which any news or editorial matter published by them, in the interest of Fire Prevention Week, can discuss the subject intelligently.

The following is representative of the educational material which the Association is sending out:

"What If Your Own Place Should Burn?"

"Back in the days when you were a boy, what fun it was to watch a fire!

"What a thrill you got out of dashing down the street—perhaps in the very dead of night!

"The terrifying peals of a brazen-throated bell gave wings to your feet. Voices tense with excitement called to one another. All along the way the windows of houses flew open. Off in the distance you could see an angry glare reddening the sky.

"Yes, it was great sport to run to a fire—back in the boyhood days.

"It is different now. A fire has become something to

Ad No. 674—2 col. x 130 lines

Concrete protects against Fire,
Tornado and Earthquake

Ask Dad—
See If He Knows

Father and mother are always thinking of your welfare—there isn't a thing within reason they wouldn't do for you.

But they may unknowingly have been risking your life every day.

When you are at dinner tonight with dad, ask him this question:

"Dad, is our school firesafe?"

Perhaps he won't be able to answer—he may not know.

Ask dad if he knows that somewhere in the country a schoolhouse burns every day. Ask him if he knows that one-third of all the schoolhouses in the country are nothing better than firetraps — maybe your school is one of them.

Of course dad knows that buildings can be built that will not burn. They are being built everywhere, every day.

If your school is firesafe, you're lucky. If it isn't, ask dad what he is going to do about it. You have a right to know.

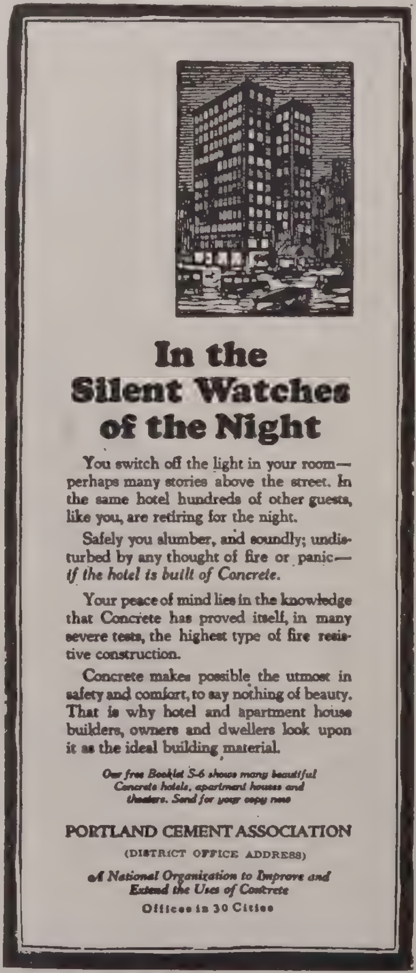
• • •

The highest type of firesafe construction is concrete. Our illustrated booklet "Concrete Schoolhouses" contains a wealth of information on firesafe construction with which every parent ought to be familiar. Write today for your free copy.

"Build So It Won't Burn"

PORTLAND CEMENT ASSOCIATION
[District Office Address]
A National Organization to Improve and Extend the Uses of Concrete
OFFICES IN 30 CITIES

Ad No. 502—2 col x 135 lines



In the Silent Watches of the Night

You switch off the light in your room—perhaps many stories above the street. In the same hotel hundreds of other guests, like you, are retiring for the night.

Safely you slumber, and soundly; undisturbed by any thought of fire or panic—*if the hotel is built of Concrete.*

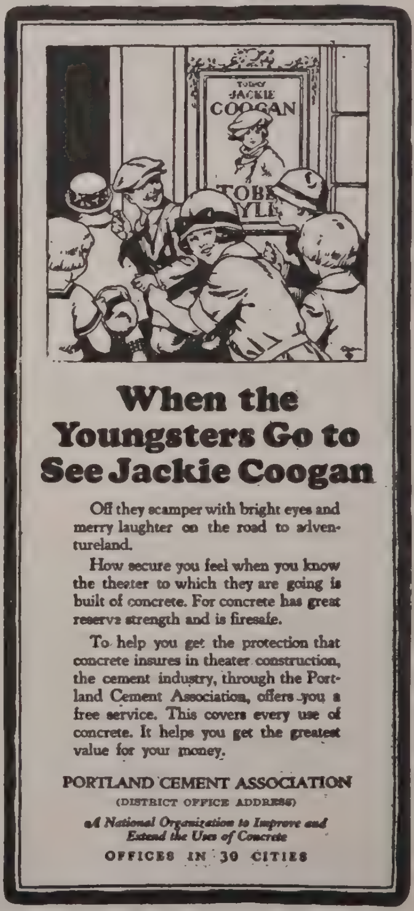
Your peace of mind lies in the knowledge that Concrete has proved itself, in many severe tests, the highest type of fire resistive construction.

Concrete makes possible the utmost in safety and comfort, to say nothing of beauty. That is why hotel and apartment house builders, owners and dwellers look upon it as the ideal building material.

Our free Booklet S-6 shows many beautiful Concrete hotels, apartment houses and theaters. Send for your copy now

PORTLAND CEMENT ASSOCIATION
(DISTRICT OFFICE ADDRESS)
A National Organization to Improve and Extend the Uses of Concrete
Offices in 30 Cities

Ad. No. 503—2 col x 125 lines


TODAY
JACKIE
COOGAN
TOB
YLE

When the Youngsters Go to See Jackie Coogan

Off they scamper with bright eyes and merry laughter on the road to adventureland.

How secure you feel when you know the theater to which they are going is built of concrete. For concrete has great reserve strength and is firesafe.

To help you get the protection that concrete insures in theater construction, the cement industry, through the Portland Cement Association, offers you a free service. This covers every use of concrete. It helps you get the greatest value for your money.

PORTLAND CEMENT ASSOCIATION
(DISTRICT OFFICE ADDRESS)
A National Organization to Improve and Extend the Uses of Concrete
OFFICES IN 30 CITIES

Three of the advertisements in the current campaign of the Portland Cement Association, reduced to a much smaller size than is being used think about mighty seriously. It means a loss—even a tragedy—to someone. And although insurance may cover part of the loss, this merely means that the cost is distributed among many—an expense that amounts to $5 each year for every man, woman and child in the United States.

"What if fire should start in your own place of business—or perhaps worse, your home? Suppose it should break out this very night?

"Are you protected by fire safe construction? If not, you are gambling with your peace of mind, perhaps with your own life—and the lives of others.

"Finally, remember that fire-safe construction actually costs less than construction which is not fire-safe.

"That is because you save on repairs. You save on depreciation. And you save on insurance. When you build—no matter what—build so it won't burn!"

The upshot of this whole campaign will be that builders, engineers, architects, mechanics, and all others interested in construction, will find the demand for new construction of a fire-safe nature of increasing importance. They will be called upon to design and construct buildings according to the newer ideas, and must be prepared for the work.

The industry can well take advantage of the movement by taking a part in it. No one is better able to tell local investors about the advantages of permanent construction than the architect, the engineer, the contractor, or the material man, whose business lies within the same town. Their work will be known, and their word respected. It is up to them to put fire-safe buildings out of the talking stage into the construction stage. National Fire Prevention week is a mighty good chance for everyone in the industry to do his share and reap his portion of the benefits.

Effect of Grading on Sand-Strength Ratios

Reported by C . E. Proudley, Assistant Engineer of Tests, Division of Tests, U. S. Bureau of Public Roads

The quality of concrete sand has been determined by means of the strength ratio test for a number of years, in however, that the two methods do not agree for determining the quality of the same sample of sand. The discrepancy has been so great in some instances as to make it possible for a sand to meet requirements for quality when tested by one method and fail if the other method is used.

The continued occurrence of such discrepancies has led to a study of the data available in the physical laboratory of the Bureau of Public Roads for the purpose of finding the factors influencing the relationship between the two methods. The first study which is described in this article embraces the relation between quality and grading as it exists for a large variety of sands which have been used or proposed for use in concrete. There is no thought, as a result of this study, of establishing either method as most suitable for indicating quality. Each method has its advantages and one test is probably as suitable as the other.

The most noteworthy observations to be drawn from this analysis are that coarse grading of sand results in an increase of the compressive strength ratio as compared to the tensile strength ratio and in general the tensile strength ratio test is more favorable to sand than the compressive strength ratio.

The data for the comparisons were obtained from routine tests made in the laboratory during the past three years. In all there were about 180 materials represented, most of which were considered satisfactory for concrete work, and some of which were doubtful. All were natural sands and covered a complete range of common types.

Reference to American Society for Testing Materials Standard C9-21, Section XIV, will give description of the method of making, storing, and testing the tension specimens. Tentative standard method C9-16T, of the American Society for Testing Materials, describes the making of compression tests, which is essentially the same as performed in this laboratory. It should be noted here that the consistency of the natural sand mortar was made as nearly the same as that of the Ottawa sand mortar as the operator could judge by close observation and feeling. Inasmuch as five operators took part in this series of tests, it is probable that the influence of the personal factor is comparatively small.

For the purposes of this investiation, it was thought best to average the 7 and 28 day strength ratios and use these figures as the quality factor of the sand. The ratio of the tensile strength factor to the compressive strength factor was next computed, in order that those materials having the same relationship of quality factors could be grouped. This means that the materials having higher tensile strength ratios than compressive strength ratios were put in one group, those having approximately the same strength ratios in another group, and so on. The mechanical analyses of each of these groups were averaged, thereby obtaining the figures shown in Table 1.

These relationships are shown graphically in Figure 1 by plotting the grading number for each sample, which is the summation of the percentages retained on the 10, 20, 30, 50 and 100-mesh sieves against the ratio of the tensile strength ratio to the compressive strength ratio. The average curve drawn on this plot was obtained by averaging the ratios in vertical columns and drawing a smooth curve through these points. This gives the average relationship between tensile and compressive strength ratios for any given grading number. The wide dispersion of the points makes this curve of little practical use other

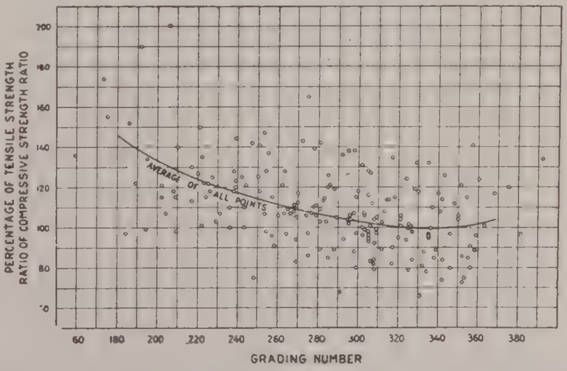


Fig. 1—The average curve shows that an increase in the coarse grading of the sand results in an increase of the compressive strength ratio as compared to the tensile strength ratio

than to indicate the probable ratio of tensile strength ratio to compressive strength ratio. It is interesting to note that the average variation of this relationship from the curve is 14 per cent.

Undoubtedly much of this variation is due to improper manipulation of the compression tests for none of the operators had had extensive experience in molding the 2 by 4 inch cylinders prior to these tests. Other factors likely to cause the dispersion of points noted are the shape of the sand grains, organic matter, and structural weakness of the grains. None of these factors can be accurately measured at present and consequently no attempt has been made to consider their influence. The use of sand from any one source graded artificially and used in a series of tests of this nature would eliminate nearly all of the incidental variables encountered in this study.

TABLE 1—EFFECT OF GRADING OF SAND UPON THE RELATION BETWEEN THE TENSILE AND COMPRESSIVE STRENGTH RATIOS

Ratio of tensile strength ratio to compressive strength ratio	Number of samples average	Mechanical analysis						
		Retained on sieve No.						Loss by elutrition
		10	20	30	50	100	200	
Per cent		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
75- 85	20	22	45	67	89	96	98	2.1
86- 95	20	20	42	67	90	96	98	2.0
96-105	37	15	38	65	88	96	98	2.2
106-115	42	13	32	57	86	96	98	2.2
116-125	26	12	30	55	84	95	98	2.0
126-135	14	17	34	58	86	96	98	1.9
136-145	13	10	27	53	81	94	97	2.7

Not many laboratories are so situated that only a single source of sand need be considered. There are usually from 4 to 25 different materials available, each of which may show changes in character as they are placed on the market. The variations shown here, therefore, would prevail to a greater or less degree in nearly all localities. In other words, the conditions of general relationship shown on the chart are applicable in the majority of testing laboratories which operate over an extended area.

Inspection of the table shows that in those instances where the tensile strength ratio is lower than the compressive the sands average coarser in grading than where the tensile strength ratio is the higher. This is shown also on the chart. The low grading numbers indicate fine grading and at this end of the curve the ratio numbers are high—that is, the tensile strength ratio greatly exceeds the compressive strength ratio in amount.

Also it is to be noted that the average curve drops to about the 100 per cent line, where tensile and compressive strength ratios are equal, and then curves upward. This is equivalent to saying that the tensile strength probably will not fall below the compressive strength ratio. The reversal of direction of the curve is probably due to several coarse sands with higher percentages of voids than the others. It seems that in molding briquettes of exceptionally coarse sands more attention is given to the compaction of the mortar than in the molding of cylinders. The result is a denser and consequently stronger briquette and therefore a more favorable tensile strength ratio.

Winter Work is Good Business

Suggestions on Winter Construction

With the approach of the period of the year when freezing weather is to be expected in the northern section of the country it is time for the contractor and concrete worker to consider seriously steps to be taken to increase the efficiency of cold weather operations. Some good suggestions to owners and architects on winter construction, which should be planned for during the summer and early fall so as to permit proper scheduling of the work during the winter months have been issued by the Committee on Seasonal Operations of the New York Building Congress.

In supporting the statement that the average layman does not take into consideration the many factors that directly or indirectly affect the ultimate cost of a building and therefore does not recognize the advantages of winter construction, the results of studies and investigations made by the Building Congress are cited as showing the following:

1. The direct additional cost due to construction carried on in cold weather is but a small percentage of the total cost of the building.
2. Such direct winter costs are more than offset by savings in other ways.
3. These conditions extend down the scale at least to operations as low as $100,000.

The indirect savings which more than counterbalance winter costs may be enumerated as follows:

1. Labor bonuses are eliminated.
2. Labor turnover is reduced.
3. Spread in overhead expenses of contractors throughout the year reduces organization and equipment costs.
4. Tendency of contractors to lower their margin of profit with the idea in mind of securing sufficient work to keep their organization intact during the winter months.
5. Seasonal discounts on materials.
6. Seasonal rates by transportation companies in order to relieve the congested periods.
7. Saving of interest and taxes on investments lying idle.
8. Earlier returns on investments.

It is further pointed out that it is true that if other conditions remain the same, winter weather adds the costs of shelter, heating, removal of snow and ice and the like and extreme cold weather lessens efficiency in certain types of manual operations. But in this connection it should be noted that official weather reports show that the number of days during which such unfavorable conditions exist are not as numerous as usually thought to be by the average person.

All facts considered, the records on winter construction confront us with the fact that labor productivity is greater on winter building and labor costs are less per unit of construction. This, together with the other advantages to be secured in the purchase of materials and in earlier returns on investment makes winter construction a good business proposition. Investigations conducted under the auspices of the United States Department of Commerce are pointed out as confirming this conclusion.

A summary of building conditions in New York for the summer of 1925, prepared by the Committee on Building Conditions of the New York Building Congress indicates that last year's 880-million dollar building program very nearly filled the immediate building needs of New York City. In 1924, while there was a continuous increase in the amount of building contracts, there was at the same time a proportional decrease in the volume of new work planned. This was equivalent to a drop in building demand relative to the current rate of supply.

Comparing the first half of 1925 with the first half of 1924, there was a decrease of 28 per cent in the total dollar value of New York building contracts and a decrease of 36 per cent in the total floor space contracted for. While these are very considerable decreases, it is pointed out it is important to note that this year's building volume to July 1, was larger than that of any other year except 1924.

An increasing amount of new work is reported as planned in proportion to the amount awarded during the first six months of 1925. This may be considered as a growth in building demands after the period of slack demand which lasted from May, 1924, to April of this year, the committee reports. Both May and June of 1925 have had larger building totals in New York than the corresponding months of last year. It is cited that building in New York has followed a course this year that has been strongly at variance with that of building in general throughout the country. In the country at large there has been a general increase in building volume.

According to statistics compiled by the Associated General Contractors of America, the volume of construction being carried on in the United States shattered all previous monthly records for the third time this year in July when the high marks set in May and June were topped. The total volume of construction performed during the first seven months of 1925 is recorded as 5 per cent greater than that recorded for the corresponding period in 1924.

Seasonal Decline Late

The seasonal decline in construction following the summer months promises to be several weeks late this year according to the statistics compiled by the Associated General Contractors. After the three months, during which all records for building activities were shattered, these figures showed no decline in August from the high mark reached in July. Furthermore, the vast number of contracts awarded in July indicates a large amount of construction is yet to be undertaken before the winter months.

The total volume of construction performed during the first eight months in 1925, exceeded that of the corresponding period of 1924 by more than 6 per cent. This fact also is being mustered to indicate the postponement of the seasonal decline this year.

Despite the enormous amount of building under way, the average of construction costs in the principal construction centers of the United States was lower in August than at any time during the past 28 months, the index figure based on 1913, showing a drop of 3 points to 198. During the past two years, fluctuations of this average cost figure have remained within 5 points, the limits being 200 and 205. A study of building material prices by the Irving Bank-Columbia Trust Co., New York, reveals the fact that the material cost of construction was lower in August than at any time since the early part of the war period. This applies to brick, lime, cement, nails, glass and lumber.

The volume of contracts awarded during July, while 5 per cent less than the total for June, was greater than the figure for any previous July on record. The total volume of contracts awarded during the first seven months of 1925 exceeds the volume for the same period in 1924 by 8 per cent.

The average of wages in the principal construction centers remained the same in August as in July. Prices paid by contractors decreased in some cities, the average of prices dropping 5 points to index number 179 based on 1913.

Awards for concrete surface pavement totaled 12,000,000 sq. yds. in July, with the figure for the first seven months of 1925 exceeding the corresponding total for 1924 by 20 per cent. Awards for pavement of streets and alleys reached the highest mark on record in July, according to the figures compiled by the Associated General Contractors.

Fewer Unskilled Laborers

The new immigration law has not only effectively stemmed the influx of aliens into the United States, as was intended, but appears to have done so in excess of all expectations during the first year of its enforcement, according to an analysis of immigration statistics for 1924-25 made by the National Industrial Conference Board. Net immigration during the fiscal year 1924-25 was less than a third, or 32 per cent of what it was during the year before.

Not only have a number of countries fallen far short of the quota allowed them, but the net gain of immigration has been considerably reduced by the heavy emigration of aliens. In the case of Italy, for instance, 20,948 more nationals of that country left the United States than entered it during the fiscal year 1924-25. Italy fell 10 per cent short of filling her quota of less than 4,000 per year.

Common labor such as is used in industry is the class of persons principally affected by the new condition accompanying the enforcement of the 2 per cent quota act. Owing to the curtailed immigration and the numerous departures of unskilled laborers a net loss of 15,106 of this class was sustained during the year, as against a net gain of 70,742 in the year 1923-24.

Among the nationals leaving this country to such an extent as to offset or exceed arrivals from their native lands, are the Italians, Greeks, Hungarians, Bulgarians, Lithuanians, Jugoslavs, Chinese and Japanese, Portugese and Rumanians. Among the countries which failed to fill their quotas are Czechoslovakia, which fell short by 17 per cent; Germany by 11 per cent; Great Britain by 12½ per cent; Irish Free State by 5 per cent; Italy by 10 per cent; Sweden by 6 per cent.

Total immigration, from quota and other countries amounted to 294,314 for the year ending June 30, 1925, as compared with 706,896 during the preceding year, before the 2 per cent quota went into effect. Deducting those aliens who left the United States, leaves a net immigration for the year 1924-25 of 201,586, 60 per cent less than during the year 1923-24 when immigration amounted to 630,107.

Canada and Mexico, according to the Conference Board's analysis, now are the chief source of immigrant labor, the influx from these two countries having yielded a net immigration of 130,193, or nearly two-thirds of our total net immigration for the year. The net gain in skilled labor during the year was 42,422 as compared with 143,416 in 1923-24.

With a smaller labor turnover in the construction field, the efficiency should be increased, particularly in the case of the unskilled laborer whose operations would be affected by cold weather conditions. Steps can be taken to train the laborers in advance of the approach of freezing weather in methods for storing aggregates, mixing and placing concrete and protecting the concrete from freezing until it has had ample time to harden.

Serious consideration should also be given to anticipated equipment requirements such as tarpaulins, salamanders and other heating equipment. In planning the layout of the storage and mixing plant on building operations that are apt to run into the cold weather period, the arrangement should be so made if possible that the additional equipment required for cold weather work can be installed without rearranging the main scheme for mixing and handling the concrete.

Uniformity in Field Concrete

In Spite of Control Methods It Is Difficult to Obtain Uniform Concrete Unless an Admixture Is Provided

By G. W. HUTCHINSON[1]

The uniformity of field concrete depends upon three factors; the uniformity of strength of the constituent materials; the uniformity of their distribution throughout the mass; and the consistency of the mixture.

The actual strength of concrete is generally designed by specifications calling for arbitrary amounts of cement, fine and coarse aggregate. Each one is required to meet an individual specification and tested by standard test methods. Such methods themselves appear to be of questionable economic value. The separate materials are proportioned, mixed and placed, and test specimens cast from the freshly mixed concrete. These are tested at given ages. The average of such tests is accepted as the strength of the concrete without regard to uniformity.

The results of tests of cast cylinders are erratic, especially so when made at the early (7 and 28 day) period. So many factors affect the early strength of concrete that the results are unreliable. These tests might serve to detect abnormal defects in the general run of concrete. Tests indicating such apparent defects, however, would tend to be overbalanced in value by tests of the constituent materials if such were carried on in the standard manner.

Fine aggregate tests by tension or compression, in mortars, do not truly indicate the strength of concrete containing them. Coarse aggregate tested by the Deval method, compression test, or other individual test methods may show rather wide variation in quality and yet give equivalent concrete strength at the early periods. At the later ages such changes in relative strength of the concrete, due to the coarse aggregates used, may coincide or conflict with the results of the individual tests of the aggregate. The Page impact test for coarse aggregate appears to be fairly consistent in determining the quality of such aggregate for resisting impact in concrete. With other factors equal, the effect of size of the coarse aggregate, however, will have a greater effect on the compressive strength and resistance to impact than any practical range in the quality of various types of coarse aggregates which possess normal concrete making qualities.

The tests for quality of constituent materials vary widely on account of the irregularities encountered in nature or manufacture; by lack of test control; personal equation; or other conditions reflecting faulty tests and test methods rather than faulty materials.

With the exception of pavement slabs, it is generally impracticable to secure specimens from the completed structure. It becomes necessary, therefore, to rely to a great extent on the results of tests from highway construction to govern changes in specifications if the quality of the finished product is to be taken as a basis.

Test Cores Show Variation

Test cores drilled from a considerable number of pavement slabs indicate that the average variation in compressive strength of the concrete is approximately one hundred per cent of its minimum strength. These tests further indicate that the distance between the locations, where such cores are taken, have no effect in reducing this variation. Variation amounting to one hundred and twenty-five per cent of the minimum has been found in test cores drilled within a few feet of each other, and sometimes from the same batch of concrete. This fact, in itself, tends to support a contention that other than the quality of the individual materials alone should be considered. More attention should be given to scientific methods of proportioning the dry materials, and to less manipulation of the wet mixture.

It appears inconsistent to stress material requirements beyond control and at the same time tolerate much greater variation in the finished concrete when due to other causes. It would appear to be more consistent to consider the average values of individual materials only, for the time being, and to study means for improvement in the method of proportioning materials and the manipulation of the wet mixture. Such procedure would be economic until a stage is reached where the variation due to the latter would be of minor instead of major importance. Unless means are taken to improve the uniformity of field concrete, economy cannot be secured. Neither is economy secured by limiting the supply of available materials, increasing cement contents, etc., while the quality of the mass in place is governed only by results of individual tests of the constituent materials. Accurate proportioning of cement and each size aggregate, and the prevention of segregation of cement and aggregate by excess manipulation during placement, require the least technical study and do not affect the normal cost. Yet they are of greatest importance. Such methods as the present proportioning directly from stock piles are very unsatisfactory.

Segregation Frequent

With reference to manipulation, tests show that the segregation of field concrete and subsequent variation in strength, bears a relation to the amount of manipulation required for placing. An example of such segregation is observed many times where hand rails of bridges have been broken. The outside presents a smooth surface up to three-eights or one-half inch in thickness. Directly back of this honeycombing is found as the result of excess manipulation in obtaining this smooth surface.

The variation in strength due to handling or manipulation of wet concrete during dumping, chuting, etc., is evident regardless of the method used in proportioning. Inertia and gravity, being related to mass, are causes for progressive separation of the various sizes of aggregate and cement from the time all materials are placed in the mixing drum until concrete has hardened in place. The larger particles being predominant, and occupying the greater unit space, are subject to the greater manipulation.

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[1] Manager, Concrete Department, Celite Products Co. Formerly Assistant Engineer, North Carolina State Highway Commission.

The action of the finer aggregate and cement in maintaining relative positions in the mass, when subjected to movement, is a direct function of the thickness and thoroughness of their coating on the larger sizes. The property required of the matrix is that which prevents separation of the various sizes, acts as a lubricant, and decreases friction during manipulation. Matrix possessing the property of clinging to, and following, the coarser particles under movement is the most desirable for uniformity. This property, termed as plasticity or more commonly "workability," is an intrinsic property of the matrix and cannot be obtained by the use of excess water.

Grading a Factor

The extent to which a concrete mixture possesses workability is a function of the amount and size of its finer particles. It is well known that concrete mixtures made from fine sand are more workable than those containing coarser sands, however, the economy of fine sand for this purpose is questionable. It affects the strength and lacks unit effectiveness. A great amount of research on the effect of finely divided powders in producing the necessary quality in the matrix of field concrete has been carried on.[2] It has led to the belief that, as the intimate knowledge of the actual variation occurring in field concrete becomes more general, the use of admixtures will become universal. It is the most practical means of attacking the part of the problem encountered after the concrete materials have been placed in the mixer.

Proper control of proportioning resolves itself into accurate separation of the aggregate into several sizes, after they have been moved from the cars or storage pile; and a recombination of each only in sufficient amount to represent one batch for the mixer. For work using aggregate up to 2½ in. in size, the material should be separated into four sizes (0-¼ or ⅜), (¼ or ⅜ to ¾), (¾ to 1½), (1½ to maximum), and then recombined in exact quantities of each. The greater the amounts of each size of materials handled, the greater the segregation. It would follow that if extremes were desired, the next step for study would be the economic size of mixer and mixing time. Until material proportioning is controlled and the handling of the wet mixture decreased, the value of field investigations appear questionable.

Dry Mixes Available

Certain conditions and proportions of mixture have greater need for workability than others. The proper amount of such admixtures would depend upon the proportions of concrete, the structure, and the qualities possessed by the admixture itself. The function of the admixture should be purely physical. It should act to a certain extent as a governor when excess water is used, and increases workability to allow dryer consistencies. By using dryer consistencies, yet workable, segregation is prevented.

The tests made by Messrs. Pearson and Hitchcock[2] (U. S. Bureau of Standards) indicate that the workability of concrete is equally benefited by one part of Celite, two parts of kaolin, three parts of hydrated lime, or five parts of portland cement. Other advantages obtained by the proper use of certain finely divided admixtures are increased strength, water-tightness, less finishing costs, and closer texture, the latter is of advantage for greater resistance to weathering.

It is apparent that considerable research has been carried on which does not contribute to the knowledge regarding the quality of concrete in place. With such information at hand and of but little practical value, it seems but logical to start from the other end of the scale and work from the field back to the laboratory; separate theory from practice, and attempt to coincide the results in a way which will secure a proper balance between quality, uniformity and cost.

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[2] Economic Value of Admixtures, Proceedings Am. Conc. Institute, 1924.

Water Content Important With "Lumnite"

Water is an important ingredient in concrete. Experiments just completed at the Bureau of Standards, Department of Commerce, show that this is just as true with the new quick-hardening high-alumina cements as with Portland cement.

The bureau finds it important to select sand and gravel in proper size gradation since less water is required to make the concrete workable and a greater strength results. The old rule, to use the least amount of water which will make the concrete workable, is found to hold with the new high-alumina cement. In one experiment a decrease of 1 per cent of water was found to increase the strength as much as 26 per cent.

The research is part of the program of the materials laboratories of the bureau upon the useful properties of materials and how they may be enhanced.

A gravel concrete made with the new quick-hardening high-alumina cement generally develops as high a strength in 24 hours as a similarly proportioned Portland cement concrete would develop in 28 days. This quick-hardening feature is notably valuable where ground rentals are high, equipment elaborate, or construction difficult, or wherever delays in waiting for the concrete to attain its strength would be costly.

The Fire-Safe Age Must Come

Fire Loss in the
United States

$16 every second.
41 deaths every 24 hours.
47 people seriously injured every 24 hours.
1 dwelling house fire every 3 minutes.
15 hotel fires every day.
5 school house fires every day.
5 church fires every day.
1 farm building fire every 7 minutes.
1 hospital fire every day.
$60,000 loss every hour.
Every minute a fire somewhere.

NINE FIRES OUT OF TEN
ARE PREVENTABLE!

**Let's Make It
the
Concrete Age!**

More Research Work

What the Bureau of Standards is Doing to Solve Many Problems Relating to Concrete

By FRANK A. HITCHCOCK

All of the general studies in cement, concrete and reinforced concrete conducted by the Bureau of Standards are carried out by the Cement Section of the Structural Engineering and Miscellaneous Materials Division. This work includes the investigation and testing of cement and related materials for construction purposes, the development of new and improved methods of testing, the design of apparatus for testing, the preparation of specifications covering cement and concrete materials, studies of various problems in the use of cement, and the distribution of information concerning it and the design and fabrication of concrete structures. The Bureau further acts as a testing laboratory for various government departments and, as far as its facilities permit, tests the major portion of all cement used in government projects.

The work of the cement section may be divided into two general classes: (1) Investigative or researches; (2) Inspection and testing of cement and related materials. These two classes usually overlap each other, as often the research problems require a certain amount of material testing and on the other hand a considerable amount of research work is done in connection with cement inspection and testing.

To care for the work of sampling, testing and shipping cement to various government projects, branch laboratories are maintained at Northampton, Pa., Denver, Colo., and San Francisco, California. The Northampton laboratory carries not only cement testing work but the other branches are equipped to do a limited amount of concrete materials and miscellaneous testing.

In connection with the miscellaneous testing of cement and other materials it appears desirable to bring to the attention of the public that the Bureau acts as testing laboratory only for the government agencies and with its limited staff and facilities cannot undertake to make tests for private individuals and concerns.

From time to time papers and circulars are published giving the results of completed investigative problems and usually once a year a report is made which summarizes the entire work accomplished during the year. In this manner the general public and those particularly interested in any of the problems can be informed as to the exact status of the work. Sometimes this summary is included in the Annual Report of the Director of the Bureau, or in order to make it more quickly available to the public it is released to one of the technical journals.

The more important investigative problems and testing work carried out during the past year are as follows:

Portland Cement Stucco

The Bureau of Standards has been studying various problems in connection with Portland Cement Stucco and its application since 1911. In 1923 it seemed desirable to build at least one more series of test panels on frame construction to dispose, if possible, of certain unanswered questions in the present practice for cement stucco. These questions briefly stated are as follows:

1. What method of attachment of metal lath to sheathing will most effectively reduce the transmission of strains to the stucco slab?
2. Is wood sheathing or open framing better for stucco finishes?
3. Is the reinforcing value of the various types of lath or fabric of sufficient importance to warrant a recommendation for the heavier types of lath?
4. Is curing of stucco by spraying to be recommended and is it worth the additional cost?
5. Is it beneficial to delay the application of the finish coat of stucco for an interval of several days as is now generally specified?

The Bureau thought it well worth the cost to try to answer these questions but its appropriations were not sufficient to provide for the erection of the required number of new panels unassisted. This matter was laid before the National Lumber Manufacturers Association, the Portland Cement Association, the Associated Metal Lath Manufacturers and individual manufacturers of wire lath and fabric. These groups responded most generously and through their co-operation a program was drawn up and carried out involving the replacement of 32 of the panels on the Bureau's stucco test structure.

Of the 32 panels of this series, 20 are backed with horizontal sheathing and 12 are either back plastered or paper backed construction on open studs. These new panels were completed in November, 1923. After they had been exposed for a round of seasons or for a period of approximately one year, a committee composed of three men from the commercial stucco interests and three members from the cement division of the Bureau was designated to inspect and rate the panels.

General Conclusions

While it is too early to consider that final answers may be given to the stated questions, progress conclusions based on the one-year inspection may be summarized as follows:

1. There seems to be no positive indication of advantage by one type of furring over another in attaching metal lath

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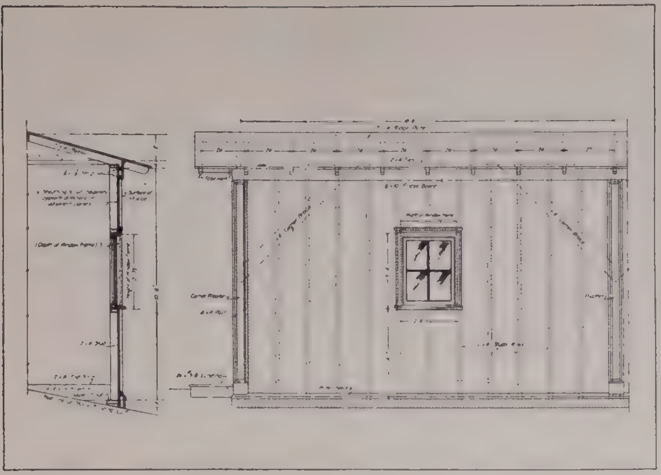

Figure 1—The framing of an end panel of the construction type of test stucco panels. (See paragraph on Portland Cement Stucco.)

to sheathing. While there appears to be some slight indication in favor of the loose tie the number of panels involved is so limited that a more extensive study would be necessary before any recommendation for a change in present practice of attaching metal lath could be made. The different depths of furring used in this group of panels varied within the limits of a minimum of 3/8 of an inch to a maximum of 1 inch. It is generally accepted that 3/8 of an inch is sufficient space back of the lath for imbedment when lath is applied to sheathing and the 1-inch depth is the greatest offset usually found in practice. Some form of furring should always be used in sheathed construction which will hold the lath at least 3/8 of an inch from the structure.

2. While the results indicate that the influence of several variables in sheathed construction such as spacing of studding, location and attachment of furring strips and attachment devices require further investigation before final conclusions can be drawn, a comparison of the range of ratings of the panels in Group One with that of Group Two suggests that, although the open type of framing, so far as the stucco itself is concerned, may have some advantages over sheathed construction, either sheathed or open frame construction is satisfactory for Portland Cement Stucco.

3. The four types of metal bases used in these tests were painted flat and self-furring diamond mesh metal lath, 24 gage weighing 3.4 pounds per square yard; 18 gage wire lath 2½ meshes per inch weighing 4.05 pounds per square yard; 20 gage wire lath 2½ meshes per inch with 3/8-inch V ribs at 8-inch centers weighing 2.48 pounds per square yard, and 14 gage paper backed steel fabric with 2-inch openings weighing 2.0 pounds per square yard. As each type has some distinct feature not contained in the others definite conclusions as to the comparative merits cannot be drawn. If the wire laths and the steel fabric are considered of similar construction, being made of wires at right angles to each other, the results tend to show that the heavier members have a greater reinforcing value, but the relation of proper spacing and size of member requires further study.

4 and 5. During the fall of 1923 while the stucco was being applied the weather was cool and wet and no results could be obtained to indicate the effect of curing as compared with no curing nor could any conclusion be drawn relative to the proper period between the application of coats. Until further information is obtained it is recommended that the present practice of the delay between brown and finish coat be followed.

Shear Tests of Beams

During the World War the great demand for ships led to the construction of reinforced concrete ships. The use

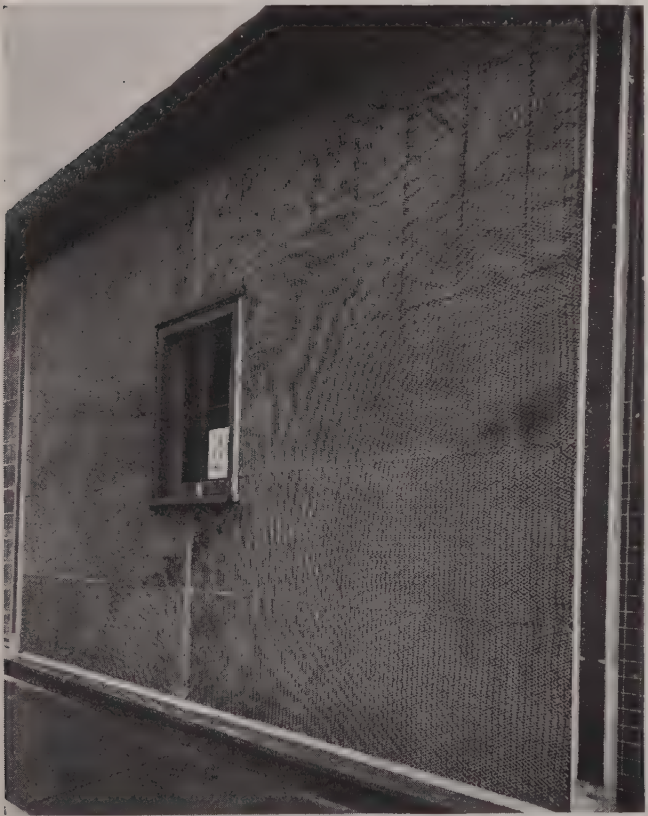

Figure 2—A panel of expanded metal lath on 8-inch crimped furring over sheathed construction ready for the application of the stucco coats. (See paragraph on Portland Cement Stucco.)

Figure 3—Application of the finish coat to one of the stucco test panels. (See paragraph on Portland Cement Stucco.)

of concrete for such a purpose necessitated a new set of standards for design. When the concrete ship was designed with the usual working stresses it was found necessary to make the wall from 12 to 15 inches thick. This would make the hull of the ship about six times as heavy as the hull of a steel ship of the same size. Then to keep the concrete ship afloat, the cargo would have to be as much lighter than that of the steel ship as its hull was heavier. It was very important, therefore, to find a means of reducing the weight of the hull of the concrete ships. Tests started immediately by the Emergency Fleet Corporation at the Bureau of Standards' Laboratories and at Lehigh University to find a solution showed that by the use of sufficient steel reinforcement properly placed in the walls of the ship it was safe to make the shell only 4 or 5 inches thick instead of 12 or 15.

The prospect that the information would be of great value in the construction of bridges and buildings as well as in ship work led the Bureau of Standards to extend the scope of the tests to include many additional phases of the problem. This work has been completed and the Bureau has now prepared the results as a technologic paper under the title of "Shear Tests of Reinforced Concrete Beams."

This paper gives the results of tests carried out on 172 reinforced concrete beams for the purpose of determining the resistance to shearing stresses. Most of the beams were of I-shaped section. This shape was necessary in order to provide sufficient resistance to the horizontal tensile and compressive stresses, and at the same time permit the development of high shearing stresses in the webs.

The web thickness varied from 2 inches to 12 inches. Most of the beams had a depth of 36 inches and a span of 9 feet 6 inches or a depth of 52 inches and a span of 16 feet. One beam had a depth of 10 feet and a span of 20 feet. The web reinforcement consisted in most cases of loose stirrups, placed vertically, or at 45 degrees with the vertical.

In all cases the bars were anchored to prevent bond failure. The strength of the concrete varied in different beams from about 2,100 lb./in.^{2} to 5,400 lb./in.^{2}.

After the beam of 10-foot depth had been loaded 40 times to an intensity of shearing stress of 727 lb./in.^{2} it was inverted and loaded to failure at a maximum shearing stress of 1,540 lb./in.^{2}. The repetition of the load had no apparent effect on the strength of the beam or on the stresses developed at high loads.

Low Tensile Stress

Very little tensile stress was developed in the web reinforcement of any of the beams before cracks appeared. Generally the cracks occurred at shearing stresses from 100 to 300 lb./in.^{2}.

The tensile stresses in the stirrups at any shearing stress were independent of the strength of the concrete used. Diagonal compression failure occurred in some of the beams made from concrete of a lean mix and reinforced with vertical stirrups.

The shearing stresses, v, (in pounds per square inch) in the beams are fairly well represented by the equation.

$$v = (.005 + r)f$$

where r is the ratio of sectional area of the stirrup to that of the concrete reinforced by it, and f is the tensile stress (in pounds per square inch) in the stirrups. This formula applies to the beams with either vertical or inclined web reinforcement.

Where vertical and inclined tension bars were present in the web of the same beam the stress in the inclined bars was greater than that in the vertical bars for all stresses below the yield point. The maximum load carried was about the same as if the web reinforcement had been the same in total amount but all vertical or all inclined.

Horizontal reinforcing bars in the web reduced the effective section to such an extent as to permit failure by horizontal shear in the web.

The deflections and crack widths were greater for beams with vertical than for beams with inclined web reinforcement.

Impact Stress in Stadium

While planning repairs for a large reinforced concrete stadium the question arose as to whether the girders possessed sufficient strength to permit adding a considerable dead weight to the present structure. Extensive load tests carried out previously have shown extremely slight deflections and indicated ample strength when static load was considered. Application was made to the Bureau of Standards for a test to determine whether moving loads causing impact and rhythmic deflections would set up stresses great

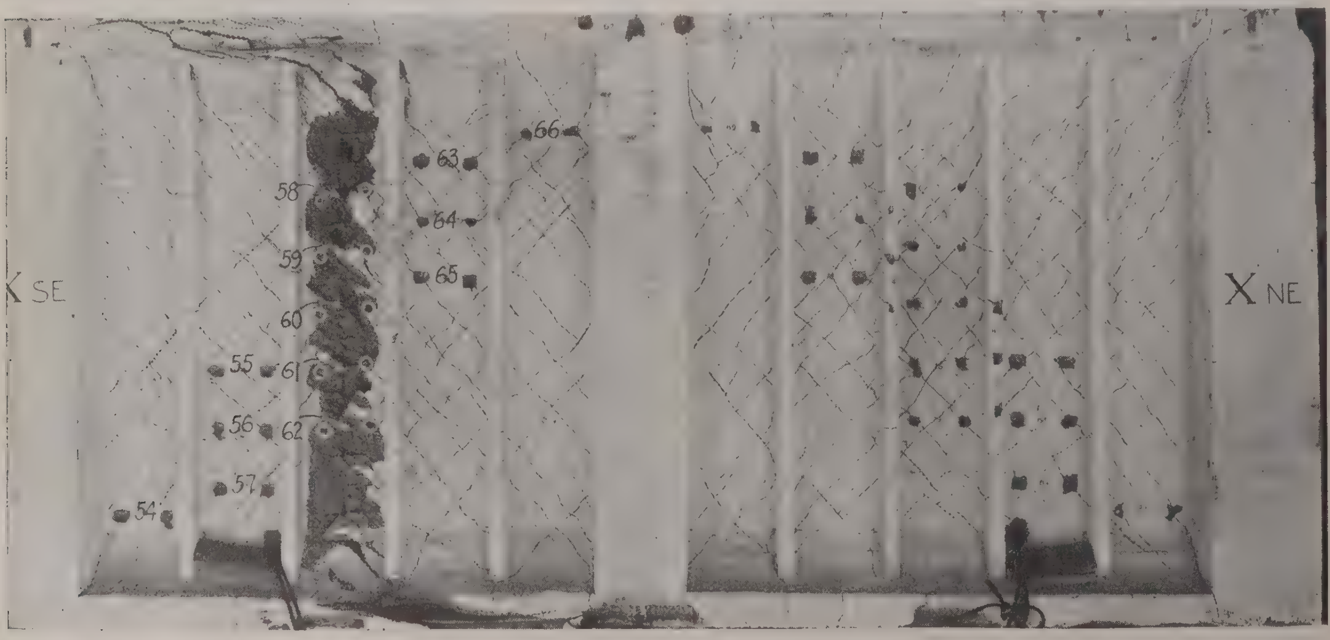

Figure 4—The beam of 10-foot depth which was loaded 40 times to an intensity of shearing stress of 727 lbs./in.^{2} and then inverted and loaded to failure at a maximum shearing stress of 1,540 lbs./in.^{2}. (See paragraph Shear Tests of Reinforced Concrete Beams.)

enough to reverse the conclusions based upon static loads.

For this purpose electric telemeters of the type described in technologic paper No. 247, were used, and observations of stresses in the reinforcement of beams and girders were made during the entire progress of a football game when the stadium was loaded to full capacity. The stresses due to all causes were very low. The indication is that the static live load stress in the steel did not exceed 1,000 pounds per square inch and that the stress due to impact or moving load of any kind did not exceed 300 lb./in.^{2}. The instrument apparently behaved well and no reason is known for doubting the indications of the tests. These results will probably prove an important contribution to available information regarding behavior of such a structure under loads causing impact. Caution is needed, however, in applying such results in other cases. A structure having less weight or a different period of vibration might show a greater stress.

The operation of the telemeter depends upon the variations in resistance to the passage of an electric current of a stack of carbon disks. There is, therefore, nothing new in the principle employed, but the Bureau was the first to apply this principle to a precision measuring instrument. Recently a new use has been found for this device in the measurement of the strains in mass concrete. For this purpose a special cartridge has been designed which houses the stack of carbon disks, and which is embedded in the concrete at the point where the measurement is to be made. Wire leads extend to the surface and are carried to some convenient point where the indicating instruments are placed. These instruments are calibrated to show any deformation in the concrete due to loading.

Proportioning for Given Strength

Present day practice in commercial concrete operations tends toward the specifying of concrete by strength for a given supply of materials, rather than the specifying of definite proportions which through long experience may be expected to furnish a concrete of the desired strength at 28 days. In order that the Bureau of Standards might have laboratory data on the present methods of proportioning the ingredients to give a definite strength at the 28-day age, a limited series of tests was carried out.

Three sands (0-No. 8, 0-No. 4, and 0-3/8) and three sizes of pebbles (No. 4 to 3/4 inch, No. 4 to 2 inches and 3/8 to 1½ inches) were included in the work. Each sand was combined with each size of pebbles, in eight different proportions. Three different slumps were used, ½ to 1 inch, 6 to 7 inches and 8 to 10 inches. The 72 mixes are found on pages 10, 12 and 14 of Bulletin 9 of the Structural Materials Research Laboratory under the size of aggregate and slump here given.

For each mix five companion 6 by 12 inch test cylinders as nearly alike as possible were made, each on a different day. In all 360 cylinders were made. The specimens were cured under damp storage conditions and tested when 28 days old. The cement used in the tests was of a standard brand meeting the Government requirements and the aggregates were washed Potomac River sand and pebbles. The 7- and 28-day tensile strengths of briquettes made from a 1:3 mortar with standard sand were 321 and 371 pounds per square inch respectively. No control specimens were made with standard sand mortar for compression tests, but from comparison of individual strengths with strengths for similar mixes reported in Bulletin 1 of the Structural Materials Research Laboratory it appears that the cement was of about the same quality as that used in the tests reported in Bulletin 1.

Water-Cement Ratio Fair

The ratio of volume of water to volume of cement in a mix has been found to offer a fair index of the strength. The expression 14,000 divided by 7 raised to a power equal to the water-cement ratio, has been proposed in Bulletin 1 of the Structural Materials Research Laboratory for determining the 28-day strength and seems to be used to a considerable extent in practice for this purpose. This expression has been used as a criterion for studying the results of these tests.

It was found that mixes in which the quantity of aggregate which passed through a No. 4 sieve was less than one-third of the total aggregate, as well as the mixes in which the quantity of coarse aggregate of some one size was less than one-third as great as the quantity of aggregate twice as large, generally gave strengths less than that shown by the expression used as a criterion. If the mixes referred to be eliminated, all the remaining mixes gave strengths as great as or greater than the criterion. In determining the quantity of coarse aggregate of different sizes, the aggregate was screened on a set of screens whose mesh opening advanced in size by multiples of two from the opening of a No. 4 sieve (0.094 inch) to an opening large enough to admit the largest aggregate. The amount of aggregate between any two consecutive screen sizes is referred to as of one size, and each size was considered to be twice as great as the next smaller size.

So far as these tests indicate, it may be concluded that the expression 14,000 divided by 7 raised to a power equal to the water-cement ratio, is a fair measure of the strength of concrete provided that at least one-third of the aggregate is sand (that is, smaller than a No. 4 sieve) and that the quantity of coarse aggregate of any one size is

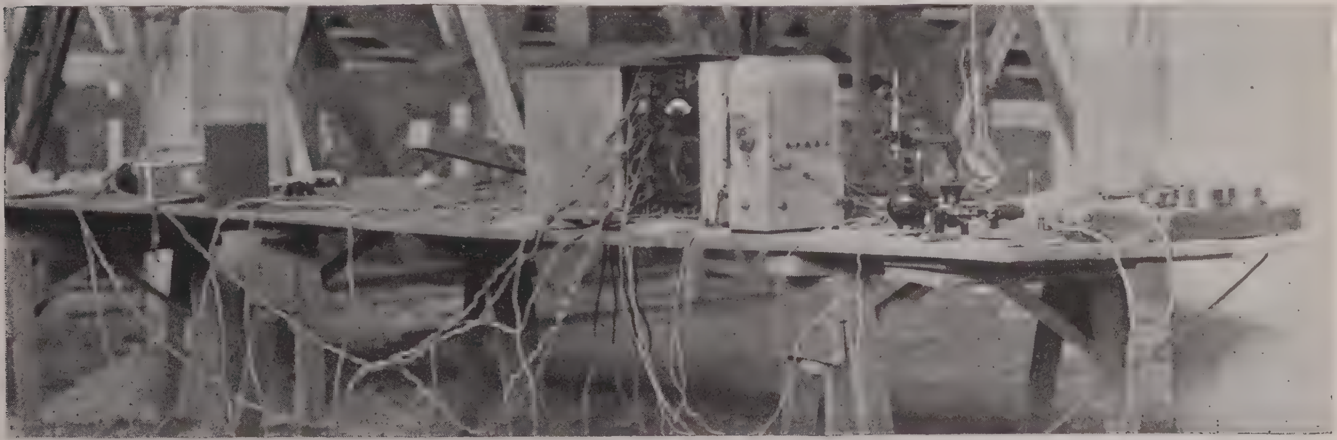

Figure 5—Temporary field set up of the electric telemeter arranged to take simultaneous readings of the deformations at six widely separated locations on the beams and girders of the stadium. (See paragraph on Impact Stress in a Reinforced Concrete Stadium.)

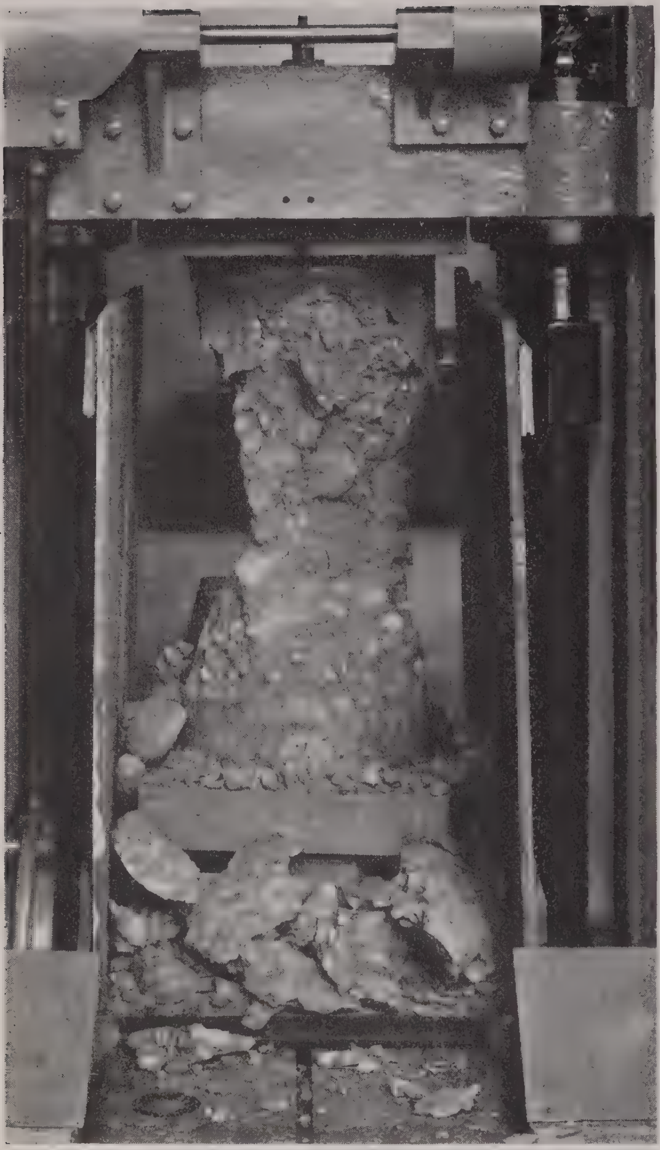

Figure 6—An 18x36 inch concrete test cylinder broken in the 600,000-pound testing machine at the Bureau of Standards. (See paragraph on The Effects of Cobbles on Concretes of Lean Proportions.)

not less than one-third as great as that of the next larger size.

Other tests not included in the investigation indicate also that the sand should not be more than half the total aggregate in order to meet this criterion.

28-Day Strength from 7-Day Tests

In the recent movement to secure strength of concrete as great at 28 days as that assumed or specified by building regulations, one of the greatest difficulties has been due to the fact that rejection of concrete which failed to meet the strength requirements was often almost impossible because of the large amount of concrete which had been placed upon it during the 28 days before it was tested. Results of recent field tests carried out on the concrete furnished in construction jobs suggested that there was a somewhat consistent relation between strengths at 7 days and those at 28 days. Further study has shown that the strength at 28 days based upon tests of laboratory specimens stored in damp sand has been equal to approximately the 7-day strength plus 30 times the square root of the 7-day strength. This relation has held true for concretes made from a large number of Portland cements and for a large range of mixes. It has held true for cements whose strength was affected by variation in fineness and length of storage and for concretes with a large variety in type and quantity of admixture, such as lime, kieselguhr, tannic acid, etc. The relation seems to be about the same for 2 by 4-inch, 3 by 6-inch, 6 by 12-inch, and 8 by 16-inch cylinders. This relation gives promise of affording a useful criterion for estimating at an early age the 28-day compressive strength of concrete used in construction work. It is very clear, however, that the increase of tensile strength between 7 and 28 days does not follow the same law as that for compressive strength.

This application to the field testing of concrete should not be confused with the problem of determining in advance from suitable tests the adaptability, for any given work, of the concrete materials proposed for use in that work. The use of the criterion here described would not remove the necessity for these latter tests of the materials.

Waste Products for Aggregate

Often a considerable amount of waste accumulates at quarries producing dressed limestone, and similar conditions exist at plants manufacturing hollow building tile. In a preliminary investigation of possible uses for these waste materials the Bureau of Standards recently carried out a few tests on concretes in which they were employed as coarse aggregates.

Forty-five 6 by 12-inch test cylinders were made in which Potomac River sand was used as fine aggregate, and Potomac River gravel, tile waste and limestone waste were each used in one-third of the cylinders as coarse aggregate. Three proportions by volume, 1:2:4, 1:2½:5 and 1:3:6 were used for each coarse aggregate. The coarse aggregate was crushed, and only that proportion between the No. 4 and 1½-inch sieves was used. The weights per cubic foot for the sand, gravel, tile and limestone were 107.4, 105.6, 72.8 and 84.0 pounds respectively. Absorption in 24 hours was 3.8 per cent for the limestone and 8.5 per cent for the tile. All mixes were brought to the same flow (of 90) as measured by the flow table. To obtain these flows the amount of water required, in percentages of the weight of the total dry materials, was about 9.5 per cent for the gravel aggregate, 13.7 per cent for the limestone aggregate and 15.4 per cent for the tile aggregate regardless of the mix. The water ratios (by volume) for the 1:2:4, 1:2.5:5, and 1:3:6 mixes respectively, for the gravel concrete were 1.11, 1.36 and 1.59; for the tile 1.47, 1.78 and 2.13; and for the limestone 1.40, 1.72 and 2.01.

Results of the Tests

The specimens were stored in the damp closet, and were tested at the age of 28 days. The strengths developed by the 1:2:4, 1:2½:5 and 1:3:6 mixes, respectively, for the gravel concrete were 1,680, 1,185 and 835 lb./in.^{2}. For the tile concrete the corresponding strengths were 2,070, 1,328 and 957 lb./in.^{2} and for the limestone concrete they were 1,525, 972 and 777 lb./in.^{2}.

The results of the tests indicate that insofar as strength is concerned the materials tested are suitable for coarse aggregates in concretes. However, both materials produced rather harsh working mixes as compared to the gravel mixes and in order to secure ease in handling and placing of these concretes it probably would be well to use over-sanded mixes.

Effect of Fine Grinding

Results were just obtained on an investigation started about ten years ago to determine the effect of fine grinding of cement on the strength of concrete. The investigation extended over a ten-year period and strength tests on concrete were made at intervals during that period. Two mixes were used throughout this investigation, 1:2:4 and 1:3:6 (by volume). Five different cements with two degrees of fineness of each were used. The extreme variation in fineness is 20.1 per cent on a 200-inch sieve. The results show that increased fineness increases the strength of the concrete over the period of ten years, that the effect of fine grinding decreases with increase in age, that various cements do not give the same increase in strength for the same increase in fineness and that at the end of ten years the strength of only a part of the concretes is increasing and by a very small amount.

Tests of an Unsound Cement

Early in 1919 considerable interest was attached to a certain lot of cement which had failed to meet the U. S. Specification soundness test. The usual cement tests were carried out on it and concrete cylinders were also prepared for various conditions of storage. Some additional briquettes were made for long-time observation and test. As a matter of interest, parallel tests were made from another lot of cement of a different brand which complied with the requirements for soundness. The results of the tests are as follows:

*COMPRESSIVE STRENGTH OF 1:1 ½:3 CONCRETE (LB./IN.^{2})

			Storage	
Cement	Age	Moist Air	28-Day Moist Air Thereafter Laboratory Air	28-Day Moist Air Thereafter Outside Air
Unsound	7 days	1700	——	——
	28 days	2090	——	——
	3 mos.	——	2810	2800
	1 yr.	——	3440	3270
	2 yrs.	——	2940	2740
	6 yrs.	——	3180	4400
Sound	7 days	1440	——	——
	28 days	2270	——	——
	3 mos.	——	3060	2440
	1 yr.	——	2960	3090
	2 yrs.	——	2310	3000
	6 yrs.	——	No specimens	4780

*TENSILE STRENGTH OF 1:3 STD. SAND BRIQUETTES (LB./IN.^{2})

	Unsound Cement		Sound Cement	
Age	Water Storage	Laboratory Air Storage	Water Storage	Laboratory Air Storage
7 days	235	——	293	——
28 days	342	——	422	——
6 years	321	131	388	446

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*All results given in the tables are the averages of three tests.

The unsound cement concrete specimens which had been stored indoors showed no apparent peculiarity. The unsound and two of the sound cement concrete specimens in the outdoor storage conditions had developed cracks, mostly of a circumferential nature. Some of these cracks, as judged by the appearance of the interior of the specimen after test, had extended to a depth of several inches. The cracking appeared more pronounced for the unsound than for the sound cement.

The briquettes in water storage did not show any signs of disintegration. The briquettes made from the sound cement and stored in the laboratory air appeared free from disintegration. Those in similar storage, but made from the unsound cement, were very badly disintegrated. The outer portions could readily be broken off by the fingers to a depth of about ¼-inch. This behavior has been noted in similar tests of other unsound cement. The tensile specimens in water storage show the retrogression not uncommon in similar long time tests. The air storage specimens for the sound cement show increase over the specification 28-day test, while those of the unsound cement show great decrease. In neither case does the tensile strength behavior bear any constant ratio to the concrete strength.

Cobbles in Lean Concretes

In connection with the various concrete projects of the Bureau of Reclamation, this Bureau particularly through its Denver branch laboratory carries out extended studies and tests of local materials for use as concrete aggregate. Inasmuch as the sites of these projects are generally not readily accessible for freight service every effort is made to use the materials at hand in as lean proportions as possible which will give the desired strengths. In a study of available aggregates for the American Falls Dam Project an investigation consisting of seven groups of tests that included all classes of concrete which might be used in construction of the dam has recently been completed. The program of the tests required six different proportions of cement to parts of separate aggregates by volume ranging from one part cement to six parts combined aggregate to one part cement to eleven parts combined aggregates.

One of the groups of tests was to study the effect of using in the concrete a certain amount of aggregate retained on a 3-inch screen and passing a 6-inch screen. The material from the local pit passing the Number 4 sieve was considered as the sand, that between the Number 4 and 3-inch screen as gravel and that between the 3 and 6-inch screens as cobbles. Two proportions were used and three 18-in. by 36-in. and nine 6-in. by 12-in. test cylinders were made from each of the mixtures. The large cylinders were cast at Denver, packed in damp sawdust and shipped to the Washington laboratory for breaking at the age of 28 days, the small control cylinders being broken at Denver at the same age. The concrete for the large and small cylinders was the same except that the large cylinders were cast first, then all pebbles greater than three inches were removed from the concrete and the remainder used to make the smaller cylinders.

The essential items of the tests may be tabulated as follows:

Proportions by Weight						Strength		
Cement	Sand	Gravel	Cobbles	Per Cent* Water	Flow	6x12 In. Cyls.	18x36 In. Cyls.	Ratio Large to Small Cyl.
1	4.24	5.33	3.06	9.2	30	1180	1080	92%
1	4.77	6.00	3.44	9.4	33	940	745	79%

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* Per cent by weight of total dry materials.

The first mix which is approximately a 1:9 mix by volume shows a loss of but 8 per cent by the introduction of the cobbles, the second being a 1:10 mix by volume shows a greater reduction of strength, some 20 per cent being lost by the inclusion of the cobbles. The results indicate for the aggregates at hand that the use of a mix leaner than 1:9 would not be economical.

Aluminate Cements

The Bureau has undertaken an investigation of the effect of storage conditions on concrete made from ten different aluminate cements. The main investigation of these cements was divided into two parts, one part consisted of concrete cylinders and beams and the other part of small mortar cubes and briquettes. All the cements used in the investigation were burned at the Bureau of Standards except one. Sufficient specimens were made from each cement to store them under three different storage conditions—air, water and a salt solution. The investigation is to continue for a period of ten years.

While the results of this investigation are yet quite complete the following general conclusion may be drawn. All cements give a high early strength and do not show an increase in strength with age.

All the salt solution storage specimens have shown signs of disintegration except those from three of the cements, two of which have not been long enough in the solution to determine if they have salt resisting properties, while the third is very slow setting and has withstood the disintegration of the solution for nearly a year. Some of the specimens of the other cements were so badly disintegrated that further observation has been discontinued.

A New Block Plant Idea

Milwaukee Producer of Cinder Block Has Worked Out A Scheme That Should Cut Manufacturing Costs

A new cinder concrete block plant is now in operation and is being completed in Milwaukee, Wisconsin. This plant has already manufactured nearly 100,000 standard 8 x 8 x 16-inch units, although the plant is not yet entirely completed. This has been accomplished by building first the foundations of the plant on which the steel building structure was erected and the roof placed, after which the manufacturing machinery and equipment was installed and the manufacture of blocks begun. All building and partition walls are of blocks manufactured in the plant.

It is planned to have this plant entirely completed and the steam heating and curing system installed and put into operation within the next few weeks. The design and method of operation of this plant is of particular interest on account of many novel features for handling material and product. The design of the plant was worked out after visits to several of the largest plants in various sections of the United States from Kansas City to New York. The plant and equipment in every detail was installed with a view of economic and efficient production, taking into consideration not only the operating labor, but also the depreciation, maintenance and carrying charges on the investment. The general layout and method of operation in the plant was designed by Mr. L. E. Pitner, Vice-President and General Manager of the company. The detail of the mechanical features were worked out by Mr. Hugo W. Weimar of Milwaukee, former engineer of Allis Chalmers Company.

The new plant, with the overhead steel bridge that handles the cinders

Detail of side of building with cinder stock pile in background, and inclined track used for the transfer of the cement cars from the freight platform to the mixer room

The plant is situated on a five acre tract of land at 591 Canal Street, in the geographical center of the City of Milwaukee on what is known as the Menominee Canal. This piece of land is 300 feet wide by approximately 745 feet long and has deep water dockage on two sides, a total of 965 feet of dock, which can accommodate any of the largest boats on the great lakes.

Cinder Supply

The corporation has made a long time contract with the Milwaukee Electric Railway & Light Company to take the cinders from their river plants. The large power plants of Milwaukee which supply practically all the power used by the industries within a radius of 50 miles, including Racine, Kenosha and other large industrial centers, are located on the Milwaukee river. Their entire coal supply comes to these plants by barge and likewise their cinders are handled from these large power plants by barges, therefore, in the locating of a cinder concrete products plant in Milwaukee, in order to avail themselves of this cinder supply, it was necessary that this plant be located on deep water.

The property was formerly a coal yard, and when taken over was equipped with two coal handling bridges reaching across the property and running the entire length thereof. One of these bridges has been rebuilt and

The plant under construction, with block in the curing yard

The south side of the plant, showing the cinder receiving hopper and the traveling bridge equipped with the latest type electrical handling machinery. This bridge has a double bucket line, each bucket holding two cubic yards of cinders. With this equipment two operators and one laborer can unload from barges or railroad cars and store in the storage piles approximately 200 yards of cinders per hour, and as the cinders are delivered in barges containing 500 to 600 yards each, it is possible to unload a barge within three hours or less.

Storage and Handling Cinders

A storage yard is arranged at the south end of the property with a capacity of approximately 40,000 cubic yards of cinders. These are handled from the yard to the plant either by buckets on the large bridge, or by a drag-in conveyor running below ground under the cinder storage pile from the plant to the end of the property. They are received at the plant in a 15-yard receiving hopper equipped with a grizzley built of 3-inch steel bars spaced 2 inches apart. The particles going through the grizzley go direct to an apron feeder which carries them to the crushing department. The large cinders or clinkers are broken on the grizzley and feed by gravity to the same apron feeder which delivers them to the crushing department. The apron feeder which conveys the cinders from the receiving hopper to the first screen is equipped with a magnetic roll separator made by the Magnetic Separator Company of Milwaukee, which removes from the cinders all tramp iron and any magnetic material that might be in the cinder mass.

Crushing and Screening

In the crushing department the cinders are received on a high speed (1800 P. M.) vibrating screen, manufactured by the Universal Vibrating Screen Company of Racine, Wisconsin. This screen is 30 inches wide and 6 feet long. The small particles feed through this screen by a chute to an elevator, which carries them to the production storage bin on the third floor of the building. The large pieces pass through a set of 36-inch Webb rolls and from the rolls to a secondary elevator, which raises them to the second floor level, where they are discharged on to another Universal vibrating screen of the same size as the one receiving them from the apron feeder. The particles which pass through this screen go by a series of chutes to the elevator carrying them to the production storage. The rejections from this screen pass through a secondary set of rolls the same size as the primary rolls and the crushed material is again elevated by the secondary elevator and discharged on secondary screen. In this manner the cinders cannot go to production storage until they have been crushed fine enough to pass through the screen.

As cinders are a very highly abrasive material, trouble has been experienced in a number of plants by the cinders wearing out the elevator buckets. This plant has, therefore, been equipped with a specially designed continuous bucket elevator. The cinders feed direct to the bucket, and are not discharged into a boot to be picked up by the buckets, as it is common in most lines of elevating equipment. The screens are adjustable, the mesh of the screens control the size of the aggregate. These screens are changed to give various sized aggregates used in the manufacture of various styles and sizes of block and tile. In all cases the cinders are crushed to such a size as to give the maximum efficiency in the finished product.

The crushing plant is so arranged that either set of rolls or screens can be shut down for repairs without tying up production. The primary or secondary rolls can operate entirely independently, and in case of trouble with the apron feeder or machinery which conveys the raw cinders to the cinder receiving hopper, cinders can be fed through an auxiliary chute at the back of the building into the crusher. This flexibility of equipment should make it possible to operate under all conditions without unnecessary delays or shut-downs which may be caused by the breaking down of machinery. In case of this emergency operation, the cinders are conveyed to the point where they are fed into the equipment by a Fordson tractor equipped with a one-yard drag-scraper. This tractor is used for other purposes about the property as well. The crushing plant will crush, and deliver to the production

Here are two views of the secondary crushing rolls. The primary rolls are in the background. The elevators that raise the crushed cinders to the upper floor may also be seen. The closeup view shows the screen at the upper right

Interior of the plant, showing overhead monorail trolleys for conveying machines and Cincrete. In background, the primary crushing rolls are seen at the left and secondary rolls at right storage bins, 20 cubic yards of cinders per hour operating under normal conditions. However, under conditions where one of the units, either the primary or secondary units, are shut down, the plant will deliver from 12 to 15 cubic yards per hour.

Crushed Cinder Storage

The aggregates on reaching the production storage bin, which is on the third floor, are received on a shuttle conveyor which automatically places them in whatever section of the bin is desired. In this way several different grades can be stored and handled from the production storage bin at the same time. Another feature of the shuttle conveyor is that it permits an even and uniform discharge over the floors of the storage bins. If all cinders are discharged at one spot the finer aggregate has a tendancy to settle at the point of discharge while the larger particles roll to the outside. This trouble is avoided by the use of the shuttle conveyor.

One of the mixers on the second floor. To the left is the traveling measuring box, to the right the sack cleaner

Mixing

The mixing floor, which is the second floor of the building, is 12 feet above the main floor or work room. It is equipped with two standard 14-foot over-sized Blystone mixers, manufactured by the Blystone Mixer Company, Cambridge Springs, Pa. These mixers are located in the north end of the mixing floor. One is right hand, the other left hand; and they are so arranged that immediately north or back of them is a bag cleaner, manufactured by the Northern Conveyor Company, Janesville, Wisconsin. As the cement is emptied into the mixer, the bags are pitched direct into this cleaner and are not handled until thoroughly cleaned. There are ten outlets in the floor of the production storage bin,—five on either side. Each five gates are connected direct with the mixer located on that side of the mixing floor, by means of an adjustable measuring hopper, or bucket, which travels on a specially-designed overhead track. When under the proper gate the correct amount of aggregate is received in this measuring bucket for one batch or mix. This measuring bucket is adjustable to receive varying quantities of the raw aggregate. For instance, if a 6 to 1 mix is used, 12 cubic feet of cinders are received in the measuring bucket, as it is a rule that all mixes receive two bags of cement. The proportion of the mix is controlled by regulating the amount of cinders to go into the measuring hopper or bucket.

Handling Cement

The method of handling cement from cars or trucks to the production storage was found to be quite different in the various plants over the country. In order to eliminate the waste of cement in handling and reduce loss to a minimum and at the same time reduce the handling to the least possible amount, a loading dock has been installed alongside the railroad tracks and roadway, which has a platform pitched away from the tracks. From this loading dock, or platform, there is a 90-foot incline runway to the second floor or mixing room where a quantity of cement is stored. This incline runway is equipped with a drag chain manufactured by the Chain Belt Company, Milwaukee, Wisconsin. The cement bags are loaded from the railroad cars onto small industrial trucks, each truck holding 40 bags or two tons of cement. These trucks are pushed out the door of the car onto the incline loading platform. The trucks run down this platform automatically, engaging the drag-in which carries them to the second floor. There is sufficient space on the second floor to accommodate 30 of these trucks or approximately 1,200 bags of cement.

The cement remains on the truck until it is used by the mixing department. It is then pushed to a position between the two mixers where it is lifted by a jacklift, the top of the load at all times kept level with the top of the mixer, thus eliminating the back breaking operation of lifting the bags of cement to the mixer. The bag is handled only twice from the time it is received at the plant; once when it is loaded on the industrial truck in the railroad car, and the other time when the bag is emptied into the mixer. An auxiliary cement storage shed is arranged alongside the railroad track at the foot of the cement drag-in where a surplus stock of cement can be maintained at all times.

Handling the Mix

From the mixers, the Cincrete (trade name of cinder concrete) is discharged into a receiving hopper which will hold one batch of the mix. The bottom of this hopper is equipped with a slide gate and is approximately 11 feet above the floor of the work room.

An especially designed overhead trolley system operates above the entire work room and kiln system on the first floor. Conveying buckets with a capacity of one batch run on the trolley. These buckets are operated from the floor by a boy. Receiving their loads from the hoppers below the mixers, they convey them to specially designed portable block, tile or brick machines at various locations in the plant.

Production Machinery

The production machines are all specially designed

Another view of the mixer showing the belt drive, the discharge opening, and the measuring box

Anchor Equipment, manufactured by the Anchor Concrete Machinery Co., Adrian, Michigan. Each machine is a self contained unit, with an individual motor attached for operating and an 18 cubic foot capacity hopper arranged for receiving the material from the trolley system, which is fed as required by a semi automatic apron feeder to the mold boxes. The weight of this machine complete is less than 3,000 lbs. and is easily moved by the machine crew from place to place in the plant, as manufacturing conditions may require, by the same trolley system which conveys the mix to them.

As the kilns are filled the machines are moved a few feet at a time; therefore the off bearers never have to carry the blocks more than a few steps in piling them. The machine operating crew consists of a machine operator and two off bearers, who manufacture, under normal conditions, from 2,000 to 2,500 8x8x16 blocks in a 9 hour day.

The Kilns

The entire manufacturing floor, with the exception of the runways and a small work room for making special products, is divided into curing kilns. These kilns are 7 feet high, 12 feet wide, and 67 feet long, divided into two sections, and with doors over the top to permit the machine to run into the kiln. As the block or tile are manufactured they are piled on piling strips with risers at proper intervals, until one section of the kiln is filled. The machine is then moved into another section, the doors are closed, and live steam turned in the kiln. The product, after proper curing, is removed from the reverse end of the kiln, the blocks being taken out in the order made.

As the block or tile are removed from the kilns the steel pallets on which they are cured are placed on small industrial trucks. These trucks are pushed alongside the machine as it is moved from place to place. The pallets in this manner are always easily accessible to the machine operator and can be moved from kiln to kiln as manufacturing conditions may warrant, without delay or expense. The piling strips and risers are piled in the kiln at the point where they are used and therefore are always accessible when needed for handling the product.

Handling Blocks to Storage

The cured blocks are loaded on 4 wheel reversible semi automatic trailers and are conveyed from the kilns in trains by Fordson Tractor to the point in the yard where they are to be stored. Each of these trailers will hold 200 blocks 8x8x16 inches. Each kiln will hold approximately 3,500 blocks and there are 10 kilns in all in the plant.

The yard has sufficient pitch toward the canal for good drainage and is laid out with two roads running the entire length of the property, one on each side and roads running across the property every 46 feet. Between each of these cross roads there is a 6 foot runway which is used for handling blocks to the yard or for handling blocks from the yard to railroad cars for shipping.

There are railroad tracks on each side of the property running parallel to the roads, and the same trailers and tractor are used for transferring blocks from yard to car that is used for removing blocks from the kiln. The trailers are loaded with blocks and towed by the tractor to the car. Runways enable a tractor to run up into and through the car, leaving the loaded trailer standing through the middle of the car. It is thus a very simple operation to load for carload shipment.

The local deliveries are handled by an independent trucking company who deliver blocks any place within 35 miles of the plant at a lesser rate than it costs to load and ship by carload. The roadways in the yard and the piling of blocks are so arranged as to make it possible to load a combination of any sizes without difficulty.

The entire plant, including the bridge, is operated by 440 volt AC 3 phase, 60 cycle electric current, excepting the lighting which is standard 110 volt AC. The plant is equipped throughout with totally enclosed self ventilated American electric motors, manufactured by the American Electric Motor Mfg. Co. of Milwaukee. This enclosed motor is used in order to eliminate troubles caused by the burning out due to dust and cement in the plant. Each piece of machinery, elevator, crusher, screen, etc., is driven by an individual electric motor; therefore, there is no line shaft or lost power in the plant.

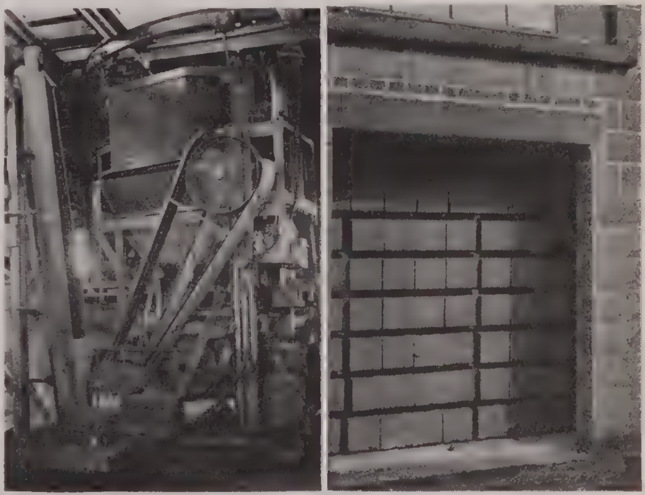
The factory is a one story building 80 ft. by 80 ft., with the exception of the mixing floor and production storage bins which are 3 stories 32 ft. by 32 ft. The overall height of the building is 34 feet, and would have been much higher to accommodate a larger stock of crushed cinders, had it not been for the fact that it was necessary to hold down the height in order to allow proper clearance for the large coal bridge to pass over the building. There is also an additional lean-to, a part of the kilns, 8 feet high on the east and west of the building extending 35 feet.

The plant is built of steel with Cincrete walls and a 10 inch 1-2-3 concrete floor reinforced and supported on 66-55 foot piles. The reason for such a heavy floor is to eliminate the possibility of any vibrating to the product before setting.

A Kewanee steam heating system has been installed for heating the buildings, furnishing steam for curing kilns and heating water for the mixing department.

This plant has a capacity of 10,000 8x8x16 blocks per day, and can be operated to capacity with a total of 35 men, as follows: 1 superintendent. 1 inspector and time keeper. 1 tractor operator. 1 crane operator. 1 trolley operator. 2 men in the crushing department. 2 men in the mixing department. 5 machine operators. 10 off bearers. 4 trailer loads. 5 yard men and 2 general laborers. Approximately 285 blocks per day per employee are thus obtained.

The officers of the Cincrete Products Corporation have naturally taken interest and pride in the construction of this plant, and have incorporated all the best features seen on their inspection trips that were applicable to their conditions and also have incorporated in their design a number of new features on some of which patents have been applied for. The management extends a cordial invitation to any interested to visit this plant at any time.



At left, the suspended block machine being filled with batch from suspended bucket. This machine is taken to the work. Right, looking through doorway into kiln, showing method of stacking

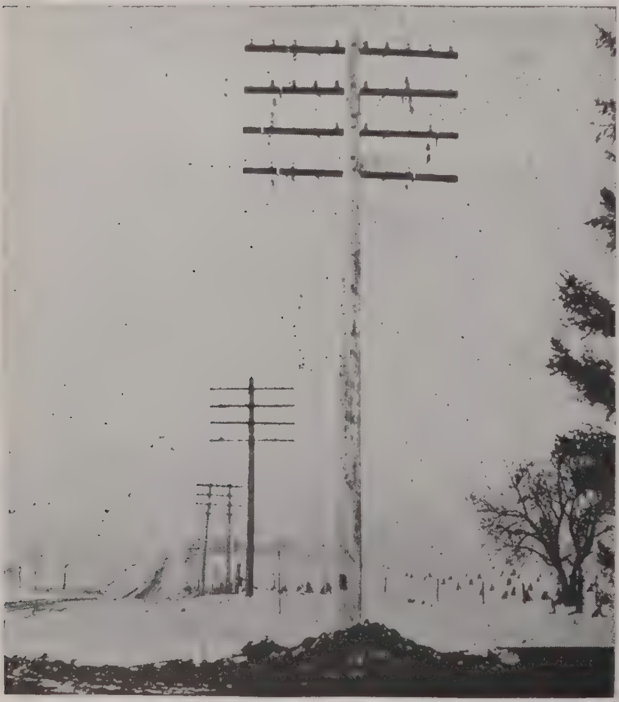
Hollow Concrete Poles by the Centrifugal Method

Various articles have appeared from time to time in the technical magazines relative to the centrifugal method for the manufacture of concrete pipe but it is thought that the importance that the centrifugal method has assumed in the manufacture of hollow concrete poles in the comparatively recent past warrants a review of some of the progress that has been made in the process. As pointed out in a paper by F. G. Welsch, concrete engineer for the George Cutter Works of the Westinghouse Electric and Manufacturing Co., the increasing cost of suitable wooden poles and the rapid depletion of their sources of supply have led users to seek a satisfactory substitute.

A number of railroads have made a thorough investigation into the matter, and after considerable experimenting have come to the conclusion that the use of concrete poles, which will withstand the most severe weather conditions and greatly reduce maintenance costs is the proper solution of the problem.

It is cited that the superiority of these concrete posts over tubular steel and wood has been clearly shown by numerous installations. The Schenectady Railway Co., operating approximately 140 miles of track near the Adirondack timber region has replaced wood with concrete. It has been estimated that the life of the concrete posts will be from 40 to 50 years or three times as long as for a wood pole. This railway has one pole that has been in use for 20 years and which today is in excellent condition.

The New York State Railways, Rochester Lines, have been manufacturing concrete trolley poles since 1913 and have done away entirely with wooden poles. The West Penn Power Railway Co. has erected a mammoth concrete tower for supporting its cables. This structure is 150 ft. high and supports the cables through a span of 1,014 ft. across the Monongahela River at Brownsville, Pa. The Niagara Falls Power Co., the Lincoln Electric Light and Power Co., the Indiana Service Corporation, Pittsburgh Railways, Illinois Steel Co., the American Telephone and Telegraph Co., and the Western Union are included among the utility companies now using concrete poles.



A line of concrete poles

In going into the history of concrete poles, Mr. Welsch points out that, contrary to the general impression that the manufacture of concrete poles is something new, this practice has been going on for 20 years, although on a smaller scale. He gives the following historical information:

The Hennebique Patents

As early at 1903 Mr. Hennebique received patent rights in France that covered a pole made centrifugally. This is the first recorded instance that can be found of the application of this force for such a purpose. Nothing much was done with his patents until 1905, when further mention was made of the process. Then a firm in Germany began experimenting with it and in 1907 or 1908 made some poles that were tested by the Royal Testing Laboratory, at Dresden. These tests demonstrated that a pole of considerable strength could be made that would also be comparatively light in weight. Prompted by this success, they began to cover their machinery with patents and to advertise the use of their poles.

In 1911 Mr. Furst, Chicago, made a trip to Germany and returned with data which he included in an article that was published in America a short while later. This raised considerable interest and by 1915 experiments were under way at Joliet, Ill., under the auspices of a company that was incorporated as the Universal Products Co. A few years later this company was taken over by the Massey Concrete Products Co., and in July, 1924, the Westinghouse Electric and Manufacturing Co. bought the plant from the Massey company. Since then much has been done to develop and improve methods of construction, and today a product is being marketed known as the Hollowspun concrete post and pole, manufactured by the Westinghouse company.

Uses for Concrete Poles

The Hollowspun concrete poles are principally used for four purposes, namely: street lighting, telegraph and telephone lines, power transmission lines and trolley poles.

Street lighting standards should not be conspicuous and it is, therefore, desirous to have them slender and graceful. The centrifugal process used in the manufacture of the Hollowspun concrete lighting standards and poles, makes it possible to produce a slender concrete post or pole without sacrifice of strength or durability. In order to carry out the idea mentioned above, that lighting standards should not be conspicuous, it is essential to employ the proper colored aggregate in order that the posts will harmonize with their surroundings or make a pleasing contrast.

The centrifugal process insures a uniform distribution of the aggregates on the surface of the post. The general effect of the post is not spoiled by blotches or inequality of surface finish, which is very often encountered in a concrete product made by the cast or jigged methods. The large percentage of mortar and air bubbles on the surface of the post are eliminated by the centrifugal force, which also insures density and a high compressive strength of the concrete.

In reinforced concrete construction the tensile stresses are provided for by the steel reinforcing and the compressive stresses provided for by both steel and the concrete. Shear stresses act transversely and to provide for these stresses spiral wire is wrapped around the outside of the longitudinal bars. The centrifugal process makes it possible to introduce sufficient shear reinforcing and at the same time place the concrete so that the steel reinforcing is properly imbedded. In a concrete product of a small section such as a post, it is difficult, and, in some cases, impossible to properly place the concrete in a structure containing the proper amount of reinforcing and insuring a dense and uniform surface.

As reinforcement is responsible for a considerable portion of the cost of concrete poles, it is designed carefully and the amount limited to the requirements of normal loading. Stronger poles with heavier reinforcement can be easily made where loading conditions are more severe.

The Centrifugal Process

When making a post or pole by the centrifugal process the steel is first assembled in the form of a cage. The required number of bars are placed on a mandrel and held in place at frequent intervals by spacer rings. The mandrel is tapered the same as the pole and of such a diameter that the cage will fit in the mold. The mandrel is then rotated and the spiral reinforcing wrapped around the bars at proper intervals and tied to the bars with bag ties at the intersections of the spiral and bars.

The cage is then pulled off the mandrel and is a stiff structural reinforcing unit capable of carry the weight of a man without collapsing. Concrete spacer buttons are then tied to the cage at frequent intervals. These buttons center the steel in the mold and become a part of the concrete wall.

The molds are made of cast iron and are machined so that when assembled to form the complete pole all joints are absolutely water tight. One-half section of the mold is placed on the bolting up table. Inserts and the reinforcing cage are placed in the mold, properly centered, and the other half securely bolted on. The mold is then ready to receive the mixed concrete.

Mixing the Concrete

The concrete is mixed in proportions of one part cement, one part fine aggregate and two parts of coarse aggregate. The batch of mixed aggregates is then placed in a standard concrete mixer and water added to get a workable mix. The minimum time of mixing is five minutes. The mixed concrete is then dumped into a skip and raised to the hopper on the tower. While the concrete is being mixed the mold is raised to a vertical position on the loading bridge. The complete batch of concrete in the hopper above is then placed in the mold through an opening on one end of the mold. This opening is then closed and the bridge lowered.

The mold is centered in the spinning machine, clamped and is rotated at a high speed. This spinning requires about ten to fifteen minutes, after which the mold is removed from the tube. The plates are then removed from the ends of the mold to let the excess water run off which was squeezed to the center by the centrifugal force. The concrete has not received its initial set, but is compacted so hard that it will not collapse and leaves a circular hole throughout the pole.

To hasten the setting of the concrete the mold is then placed in a steam curing pit which has a super saturated heat of approximately 150 to 170 degrees F. After about two hours the mold is removed from the steam curing pit and can be then stripped from the pole. Molds can be used twice in one day.

The pole is kept wet for a period of 14 days to increase the strength of the concrete. Keeping concrete wet while it is curing increases its strength, but leaving excess water in the mixture decreases its strength. In the Hollowspun process of manufacture this "water" problem is overcome by the centrifugal force, which squeezes the excess water to the center and it is then drained off as mentioned above.

The finish of lighting standards by the centrifugal process insures a uniform distribution of the granite particles on the surface of the post. Blotches or inequalities of the surface finish, which are very often encountered in concrete product made by the cast methods, are eliminated. It can readily be seen that by this process the larger particles and particles heavier than water are forced to the surface. If it is desired to have surface finish showing the granite or marble aggregate, the post is brushed with a solution of muriatic acid and then washed off with clean water to remove all traces of the acid.

After the posts or poles have been cured for a month, they are ready for shipment.

Concrete Planks on This Bridge

In order to minimize interruption of traffic while the roadway of a bridge in Ontario was being replaced, it was decided to re-pave with reinforced concrete planks in place of the existing wooden deck. The roadway of the bridge was 18 ft. wide and the "planks" were cast in lengths of 11 ft. and 7 ft., in each case the section being 12 in. wide by 4 in. deep. The reinforcement consisted of three 3/8-in. round longitudinal rods and 1/4-in. transverse rods at 4-in. centers. The edges were grooved and tongued so that the "planks" fitted into each other. Altogether 520 of these "planks" were used, the joints being grouted. The units were made near the site of the bridge and cured for 28 days before the work of replacement was started. The old timber was removed and the concrete units placed in position at the rate of 80 or 90 a day, and the work was so arranged that traffic was only kept off the bridge for eight out of each 24 hours while it was in progress. Doubts were expressed as to the ability of the steel trusses to carry the extra weight of the concrete decking, but it was found that the new floor was only 30 per cent heavier than the existing rain-soaked timber. By this method not only has a permanent deck been obtained, but as the floor is supported direct on the steelwork, the method adopted avoided the expensive formwork which would have been necessary had the concrete been poured *in situ.—Concrete and Constructional Engineering.*

Sanitary Works for Uruguay City

A contract has been signed between the Uruguayan Government and a local construction company for the construction of sanitary works in the city of Rivera, according to consular advices to the Department of Commerce. The amount involved is 594,388.54 Uruguayan pesos gold (present value peso is $0.997).

Bridge Erected in New Manner

Modern Methods on This Project Bring Economy and Give the Taxpayer His Money's Worth

The engineers are forcing real work onto the public in spite of political interference. As mentioned in "Concrete" for September, the new order of things is being demonstrated, even though at some cost to the engineer who places ethics and public interest above ambitions and desires of politicians and their chosen friends.—More power to them!

This view of the new bridge, taken in August, shows the arch centers in the first span in process of lowering, and the slab forms on the middle section removed

In 1922, Hennepin County, Minnesota, decided to build a bridge over the historic Minnesota River between Fort Snelling and Mendota. The bridge had been talked of for many years. The broad deep gorge of "River Warren" of glacial times through which the modern Minnesota River threads its way has long been a barrier between the city of Minneapolis and the rich trade territory to the south and east. The automobile and motor truck forced the issue until it could no longer be avoided. The state legislature was asked to appropriate $2,600,000—for the construction of the bridge. Very wisely they decided to appropriate $1,800,000—to take care of the requirements for the next two years and suggested that the County Board could come back to the next session of the legislature with a request for the additional funds required.

The first problem, after financing had been arranged for, was the location of the bridge. The County Board directed the County Surveyor to make the necessary surveys. About $12,000 was spent before the Board decided to employ special engineers to take care of the project.

The project involved a large expenditure. It had been backed by the business interests, and the County Board determined to show them that their confidence had not been misplaced. Accordingly they decided to proceed as nearly as possible along the lines which efficient private business would pursue. They decided that they must secure the services of thoroughly competent engineers. After due consideration, they chose Walter H. Wheeler, member of the American Society of Civil Engineers, and the C. A. P. Turner Co., Associated, and the work has been under their direction from the beginning. When the matter was first discussed between Mr. Wheeler and the Board he frankly told them that if there was to be any politics in the job he would not be interested in it, but that if it was to be free from politics and conducted in a business-like manner he would be glad to undertake it. The Board agreed heartily that there should be no politics and that they were very anxious that the work be handled in an efficient and business-like manner, and Mr. Wheeler is authority for the statement that they have kept their word.

Roads Included

Included with the bridge are five miles of connecting roads which link it up with Minneapolis, the South St. Paul Stock Yards, and the main trunk highways of Minnesota. The engineering included the location of the bridge and the highways, soundings for the bridge, surveys, plans, specifications, supervision and inspection of the grading and paving of the highways, plans, specifications, supervision and inspection of the construction of the bridge. At the present time, the entire project is under contract, except the pavement surfacing on the bridge which is to be let later. Ten separate contracts have been let on the work.

The County Board required a $50,000 bond from the engineers to guarantee faithful performance of their contract. The board has followed the recommendations of the engineer at every step in the progress of the work. Every contract has been let to the lowest responsible bidder regardless of political influences and sometimes in the face of great pressure. They are holding the engineers responsible. They have confidence in their ability and judgment and like intelligent business men they rely upon their advice.

Description of Bridge

Work began on the roads in the fall of 1923 and the heavy grading was done at that time so that the fills would have ample time to settle before paving. Work began on the bridge in the spring of 1924 and the contract calls for completion in the fall of 1926. The bridge is 4119 feet long, 60 feet high and 120 feet high above the water. The piers which are all complete extend to an average depth of about 70 feet below the surface to bed rock. The superstructure is a two-rib arch design with a flat slab deck carried on columns from the two arch ribs. There are twelve and three-quarter arch spans 304 feet center to center of piers. At one end is a short trestle approach. There will be about 75,000 cubic yards of concrete in the bridge. The contract price for the bridge complete is $1,870,000, or $7.50 per square foot of bridge floor area, and the total cost of the project according to the contracts which have been let including engineering, will be about $2,300,000, which is well within the appropriation originally asked for.

Making the Concrete

The design of the concrete plant was carefully checked by the engineer to see that it would perform its work precisely and as near automatically as possible. A careful check is kept on the water content of the concrete. Between 6½ and 7 gallons of water per bag of cement is used, including the water in the aggregates. The aggregates are very carefully selected to insure high resistance to the action of frost and are carefully graded for size. Only washed sand and gravel and selected crushed rock, free from dust, are used. The specifications require a maximum strength of 2400 pounds per square inch at 28 days. Tests so far made show 2500 to 2800 pounds per square inch at 28 days. The specification for aggregates has in it a provision which requires that the aggregate shall not absorb more than 1 pound of water per cu. ft. when tested according to A. S. T. M. specifications. Some crushed limestone and also some trap rock have been used in the work and test cylinders taken of the concrete. The gravel concrete has tested higher at 28 days old than the crushed rock concrete. At 7 days the crushed limestone concrete tested higher.

The program which the County Board has followed on this job has been very successful so far. Due to these methods they are getting the work done at a lower cost than they expected and at a cost which is extremely low for such a bridge. If all engineers would insist upon the elimination of politics from the handling of public work far better results would be obtained and the standing of the profession raised greatly in the eyes of the public.

Fighting Politics

"Unfortunately the adoption of such a policy as the Hennepin County Board has followed does not meet with the whole-hearted approval of those who have been accustomed to the old 'pork barrel' methods of handling public work. The program has also met with strong opposition from the County Surveyor who had expected to handle the work through his office," the engineer stated.

"Under a statute which permitted seven tax payers to appeal from any claim allowed by the County Board, and under which the County Attorney was required to take the case of the tax payers without any obligation or expense to these tax payers, an appeal was taken on the second payment to the engineers. The law did not require that any grounds be stated in the appeal, merely that the tax payers serve notice of an appeal. The engineers were compelled to carry this case to the court where the legality of their contract and their claim was upheld, at considerable expense to them, some expense to the County, and no expense to the tax payers, who failed to make any appearance.

"This law was amended at the last session of the legislature of Minnesota, through the efforts of the Minnesota Federation of Architectural and Engineering Societies. It is now required that the tax payers state the grounds for their appeal and give bond to protect the County.

"Later a suit was brought by tax payers against the individual members of the County Board to recover money paid the engineers on their contract for engineering on the approach roads. The contract was supplementary to the engineering contract on the bridge. This suit also failed.

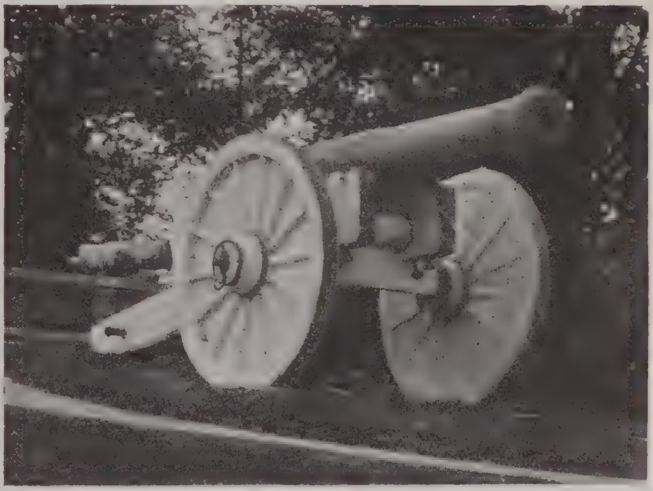
"The latest development is a report made by a Hennepin County Grand Jury in which they recommend that the next Grand Jury investigate thoroughly the whole matter of the Fort Snelling-Mendota bridge and assert that the record shows that the original estimate on the cost of the bridge is being exceeded by $1,050,000. This report is without any basis whatever in fact, and has been severely criticised by all three of the daily papers in Minneapolis. The foreman of the Grand Jury has since publicly admitted that they obtained these figures from the County Surveyor's office. The engineers in charge of the job were not called to appear before the Grand Jury. This same Grand Jury, after investigating the County Board, has returned trivial indictments against two members of the Board. One on the charge of receiving a contribution of $25 toward his campaign fund which he did not report, and the other on the charge of threatening a witness.

"It requires courage on the part of public officials to go against such obstacles in the discharge of their duty, and it is to the credit of the Hennepin County Board that they have continued to do so."

The above story on the political troubles on the job, as told by Mr. Wheeler, is an indication of what many engineers run up against when they try to promote good and economical public works. The engineer will find much of interest in his statement, which has been given for what it is worth.

Concrete Again Replaces Perishable Wood

Our history books told us, when we went to school, that there was a great fight long ago between American and British forces on old Lake Champlain. Today, long after those hectic days are all but forgotten, a captured British cannon stands on guard at the Saratoga Battle Monument, Schuylerville, New York. This five-ton piece of ordinance was originally mounted on a carriage of white oak; but the passing of the years, as usual, left this wood badly rotted. In order that future generations might be able to view this captured cannon in somewhat its original state, the services of concrete were commanded to make a reproduction of the wooden carriage. Mr. T. J. Hanrahan, of Schuylerville, made the reproduction with reinforced concrete, and the old trophy now stands at the monument, good for generations to come. Here, again, we see concrete chosen for permanence.



The old captured British cannon, at Saratoga Battle Monument, with its new carriage of reinforced concrete replacing the rotted one of white oak

Good Promotional Work

Wisconsin Products Manufacturers Show the Public How Strong a Concrete Block Really Is

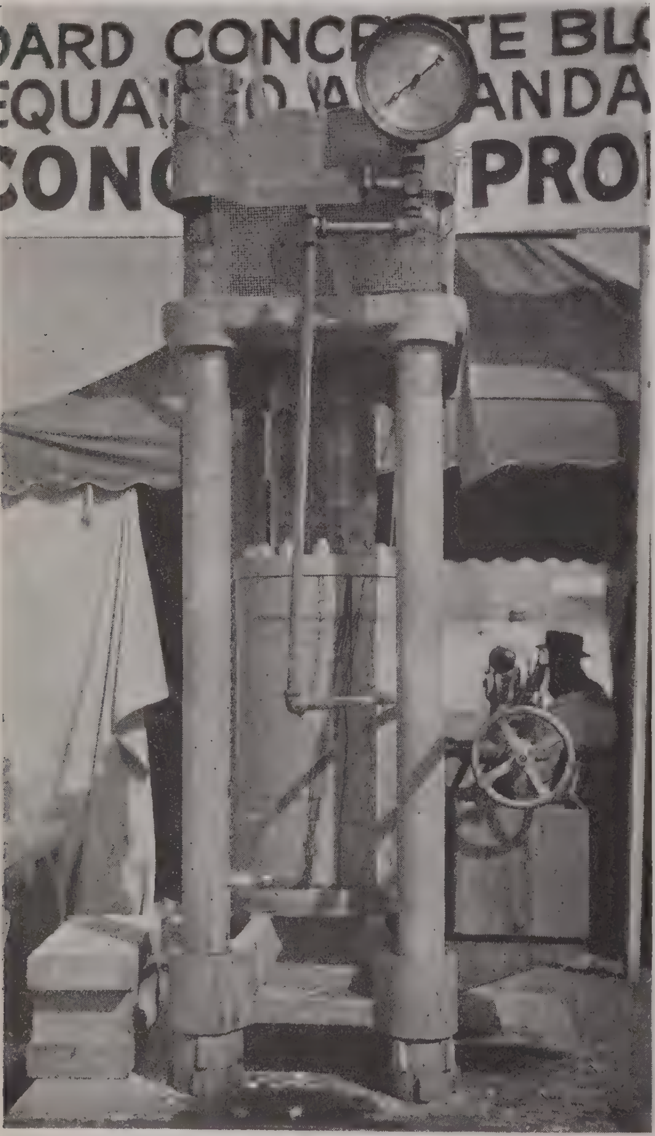
Acting under the theory that most people realize that a concrete block or building tile will hold tremendous loads, yet few realize exactly how much, the Wisconsin Concrete Products Association, cooperating with the Milwaukee County Branch of that Association put on a rather striking exhibit at the 1925 Wisconsin State Fair.

In order to show the public exactly the great load that these units would carry, the testing machine owned by the Association was brought into play and concrete building units were tested on it at periodic intervals throughout every day of the Fair. A substantial concrete base was put in place and the testing machine mounted on it. An attendant was in charge who, together with Milwaukee County products men, explained the merits of concrete masonry construction and showed by actual tests carried on at regular intervals just what tremendous loads these units would carry. Visitors were encouraged to guess the weight that would be carried by each unit tested.

Tests were made every hour starting at ten o'clock in the morning and with few exceptions practically one hundred guesses were reported on each unit tested. Members of the Products Association drummed up trade and invited those passing the exhibit to step up and take a look at the unit which was to be tested, examine it and gave them a short talk on the merits of its use in building construction, both large and small.

The fact that a great deal of educational work needs to be done along these lines was brought out by the guesses recorded on the various units. Some people hesitated at estimating that a concrete building block would hold a load of 3,000 pounds, while others, who evidently had read some of the promotional literature put out by the Association came very close to the actual tests recorded.

The block and tile were capped and displayed for an hour or two hours before they were actually tested and everyone guessing was given an opportunity to examine records to show the strength carried by the units tested the previous day. This not only prevented some of the guesses from going entirely wild, but gave the guessers a keener realization of the loads sustained by concrete building units.



This Testing Machine Was Set Up at the Booth and was Used to Demonstrate the Strength of the Units

This Sort of a Crowd Watched Every Test That Was Made, and Took an Active Interest in the Entire Proceedings

EACH STANDARD CONCRETE BLOCK WILL CARRY
A WEIGHT EQUAL TO A STANDARD PULLMAN CAR
WISCONSIN MILWAUKEE CONCRETE PRODUCTS ASSN.

This is the Concrete Products Booth at the Fair, That Resulted in Valuable Education of Prospective Builders

At practically every test the roadway in front of the exhibit was completely blocked by those watching the man operating the testing machine. As the gauge on the machine slowly climbed around to the ultimate load, members of the Association announced its progress.

The entire exhibit was under the direction of George Yunker, Art Devos and F. W. Zilisch of the Milwaukee County Branch of the Association and due credit must be given them for the time and effort they expended in making it the success which it proved to be.

Who Pays for "Free Service" Cement Sacks?

Courtesy Universal Portland Cement Co., Chicago, Ill.

Since the world began, man has always been on the look-out for something for nothing. It has been human nature, since Adam and Eve tried to get knowledge by eating the apple in the Garden of Even, for everyone to strive to obtain some advantageous thing free of charge.

But the "gifts" in business of free service, free packages, free delivery—so desired—are not so generous as they seem. There may not be, so far as the customer is concerned, any visible charge for these items. In fact, a service often brings in enough business to more than pay for itself and so does not raise the price of the commodity. Yet the cost of rendering service is a part of the cost of doing business and must enter into it just as wages, rent and other items do. In this way, service costs money.

In business there is a constant cry for more and more special service. Customers expect a concern to perform this service and good business concerns do. In some instances, no visible or separate charges are made the customer for this, while in others, the charges are clearly itemized.

The Non-Returnable Package

When you get a bottle of pickles at the grocery store, you don't get the bottle free. The price you pay is not only for the pickles—it also includes a charge for the bottle. It is not a separate item. It is not *so* much for the pickles and *so* much for the bottle. But the pickle man certainly charges you for the container. Nor does he give you a refund for returning it. The reason is that its value is not as great as the cost of the work involved by the retailer, jobber and maker in paying for, collecting, storing and cleaning the empty bottle. The same is true in the case of a can of tomatoes, a sack of flour, a box of candy, or a barrel of apples. Part of the price you pay is for the container.

The same is true in the case of paper cement bags. The price you pay for cement includes the charge for the package. And as the package is not usable again, there is no refund if you return it.

The Returnable Package

In general, the same also is true for the cloth cement sack but with this exception; the package is more readily and economically usable again than is the pickle bottle, tomato can, flour sack, candy box, apple barrel or paper cement bag. In fact, the cloth cement sack is so economical a package for the cement user that he specifies it for about 90 out of 100 sacks of cement shipped. This means that 90% of the users of cement prefer taking their cement in cloth sacks rather than in any other way.

In the case of any package for any commodity, the user of the commodity pays for the container, be it carton, sack, tin, bag, barrel, bottle or box. If it is a paper cement bag he pays the entire cost at once and there is no refund for the returned package. If it is a cloth cement sack, he pays only for a part of the total package cost. He pays for those sacks that are lost, diverted to other uses, or made unfit for further use because of damage by water or other agencies, torn beyond repair through misuse or worn out. When he returns the others to the seller, the full charge originally made is refunded to him. Thus it is that the cloth cement sack comes nearer being a free package than any other container.

The economy plus the convenience of the cloth cement sack is what makes the user prefer it so strongly over other methods of shipment. But the cloth sack, like other containers, costs money and this cost goes into the cement maker's manufacturing or operating costs. Every business organization, to continue its existence, must require its customers to pay its entire manufacturing, operating and other expenses. That is the only basis on which a concern can remain in business. If it does otherwise it will fail.

Cloth Sacks vs. Paper Bags

Comparative figures show that if the user takes his cement in cloth sacks, which are returnable, his package cost, on the average, is about one-third as great if he takes it in paper bags which are not returnable. Through proper care of cloth sacks, the user can keep his package cost decidedly below this average. That means that the cloth sack is providing the service of keeping his cement cost down.

On the other hand, the packing of cement in *paper* bags is advantageous to the cement maker. He has none of the detail work and expense such as is incurred in the handling of returned cloth sacks. His only investment is represented by an inventory sufficient for current needs. The use of *cloth* sacks, however, requires an investment in buildings and equipment for receiving, cleaning, counting, inspecting and repairing sacks returned by his customers and for tying and storing both old and new sacks. In addition he has also the costs of labor for these operations and the expense of clerical work in keeping records and issuing credits. Then he must provide at all times a sack reserve sufficient to insure uninterrupted shipments of his product, which means that he must carry an investment in cloth sacks which at the beginning of the season is very large.

Service for the Buyer

In the face of this, surely no one can doubt that the cement maker or dealer, could he have his preference, would favor a non-returnable container.

Why doesn't he then? Simply because users generally prefer the returnable cloth sack—because they specify it for about 90% of all the cement shipped—because it is good business for the seller to supply his product in the container his customers prefer.

In other words, the seller finds that the service thus given the user is worth the difficulties of performing it. In rendering this service, specified and preferred by users, the seller must charge his various sack handling costs to his overhead or operating cost. In like manner, the buyer should charge these items to his costs of handling cement.

Protects Careful Users

By charging for the package along with the cement and allowing credit for it on its return in good condition, the seller requries each user to replenish the supply of sacks *only in proportion to his share in its depletion.* If, through accident or otherwire, the user loses or destroys 10 sacks, he pays for 10 sacks. If he loses or destroys 1,000 sacks, he pays for that number. Thus a fair and equitable basis is established so that careful users do not pay for losses caused by careless users.

It is only when the buyers of cement pay for the sacks in proportion to their share in the depletion of the supply that this fair basis can be maintained. Some users of cement feel that full credit should be allowed on all sacks returned whether serviceable or useless. In other words, they favor the cloth sack as a free package. Were the cement maker to do this, it would result in negligence on the part of users in the care and return of the sacks, and with the decrease in sack returns, there would be an increase in the cost of operation to the seller which would obviously bring an increase in the price of cement in proportion to the negligence. This would mean that a man who was careful in handling sacks would have to pay a higher price for cement caused by the careless user who neglected to return his sacks in good condition or to return them at all.

Cement users quite generally agree that they should pay for sacks damaged by water or other agencies while in their hands. Certain ones, however, feel that they should not pay for sacks worn-out in service through natural wear and tear. All users help to wear out the sacks in which the cement they use is packed. Thus all users naturally should bear their share also of the expense of replacing sacks worn out in this way. In other words, the cost of replacing worn-out sacks is just as much a part of the cost of producing, selling and shipping cement as the cost of replacing sacks that are irreparably damaged or not returned. In the end, the user must pay this package cost the same as he does for sacks he loses or misuses and fails to return. It is no different from what the user of any commodity does. If the cement maker or the retailer absorbed the cost, he would have to add it to the cost of the product and in the long run the user would have to pay for it nayhow. Furthermore, if it were done in this way, it would upset the entire equitable practice now pursued whereby each user pays directly only for the sacks which he receives and which are made unserviceable for any reason while in his hands or are not returned.

What Makes Cloth Sacks Useless

Roughly one out of every eight sacks shipped goes out of service for one reason or another. The principle reason is that the sacks are allowed to get wet. Other causes include the diversion of sacks to other uses, the rendering of sacks useless on account of misuse, and the natural wearing out of sacks through continued service. Much of this loss can easily be prevented through better care of sacks and the cement user can thereby keep his package cost at a very low figure. On the average about five times as many sacks never are returned, as are found to be useless after return to the mill.

A sack cannot last forever. It will eventually wear out. And since the user must in the end pay the package cost, the fairest, and what has proved to be the most equitable method, is to charge the user directly for the sacks which have just merely worn out in his hands, as well as for all sacks made useless while in his hands and sacks which he fails to return.

On this basis, the retailer in cement should not absorb any sack loss unless sacks are lost, destroyed or diverted to other uses while in his *own* hands. Any sacks returned to him in unserviceable condition should not be credited to his own customers just as the manufacturer does no credit useless sacks to his customers. At times the argument is advanced that the retailer must allow full credit for returned sacks, regardless of condition, in order to hold his accounts. While this is not sound business, the retailer should, if he follows such practice, charge the loss to his selling cost and not to the cement maker.

A Service for the User

The cement maker and the retailer furnishing cement in cloth sacks are performing a service to their customers. In charging them for the sacks lost, destroyed, or returned in useless condition, they are merely carrying out a sound business practice such as the users themselves would do if they were sellers. The sellers inconvenience themselves in furnishing cement in cloth sacks and are willing to do this because the returnable cloth sack is more economical for the user than any other form of package yet devised and because the user prefers this in spite of whatever inconvenience it may cause. It is just another case where the advantages outweigh the disadvantages. In the practice as here outlined, cement maker and dealer charge the user only in proportion to the number of sacks which he loses or renders useless, and thus enable the user to obtain cement at a lower cost.

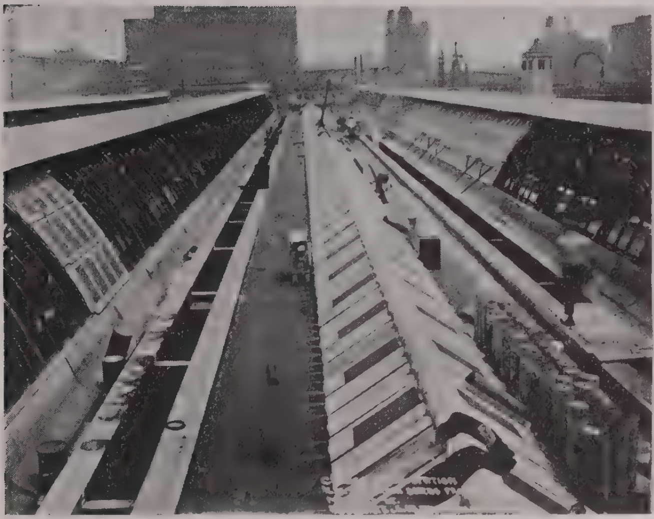
The cloth sack used in shipping cement is not a free package. It costs money. Some one must pay for it. And it would not be fair to the careful to require them to pay for the carelessness of others. The practice of charging for sacks lost, destroyed or returned in useless condition is most advantageous to the buyer in every way. While this means additional work for the cement maker and the dealer, it provides the basis for what the user himself prefers. It keeps the cost of cement down for him and therefore keeps the cost down on all construction in which cement is used.

Just as the pickle bottle, tomato can, flour sack, candy box, apple barrel and paper cement bag are paid for by the user, so must the cloth cement sack be paid for by the user. There is no such thing as a free package. A near approach to it, however, is the returnable cloth cement sack. Considering the service it performs and the value of the product, it costs the user proportionately less perhaps than any other container for any commodity. The reason for this is that, unlike most containers, it is returnable which thus enables it to make many round trips during its life and so keep down the cost of an important building material that enters into almost every form of construction.

Paper sacks are being tried on many jobs. What do you think of the idea?

Roofing Tile on New Depot

A Light-weight Economical Roof Provided for Famous Mid-Western Structure



View of Train Sheds Showing Steel Frame Supports and Precast Cement Tile Roof Partly Laid

An interesting feature of the new Chicago Union Station which was opened May 15, 1925, is the use of concrete roofing tile on the main concourse, train concourse and train sheds. The tile adopted represents several novel features in design.

These features were needed because the location of the station produced unusual engineering designs to which the tile had to conform. The station stands on the west bank of the river just west of the "loop" district. The station proper is on the west side of Canal Street with the train concourse and sheds on the east side conforming to bank of the river.

The tile were manufactured by the Federal Cement Tile Company of Chicago. According to one of the engineers of the Chicago Union Station Company comparatively low cost, ease of erection, relatively light weight, durability, substantial appearance and ability to admit light were the features which governed the selection of this roof covering.

The roof over the tracks presents an appearance of a series of alternate high round gables, and low peaked gables, with the high gables over the passenger platforms and the low gables over the baggage platforms. Between the rows of high gables are smoke slots for two tracks.

The steel construction which supports the tile roof rests on columns running down the center of the passenger platforms. Flat arch girders span the tracks and baggage platform allowing unrestricted movement on this walk. On the top of the supporting columns a heart shaped truss supports the row of tile forming the sides of the louvre and also the row of tile forming the ventilating roof.

In order to provide precast tile that would insure a perfect fit to the curves and angles of the steel frame resulting from this design, it was necessary to provide 11 varieties of tile units for the standard portion of the shed and special units near the outer ends where the tile conforms to the curves of the converging tracks.

The ventilating hood at the top of the passenger platform monitor is covered by two curved slabs—1¼ in. thick, 24 in. wide and 36 in. long. A special cap unit covers the joint at the ridge. Three rows of curved tile 1⅛ in. thick, 24 in. wide and 36 in. long, each containing a pane of ¼-in. rough wire glass, 20 in. by 30 in., provide a continuous skylight on the side of the monitor.

On the baggage skylight interlocking tile 1⅛ in. thick, 24 in. wide and 52 in. long form each slope with a standard ridge cap on the ridge. Each third interlocking tile on both slopes is provided with a pane of glass 21 in. by 35 in. Channel-section slabs approximately 18 in. wide by 8 ft. long cover the remaining portion of the shed roof between the baggage platform, skylights and the lower edge of the passenger monitor skylights, exclusive of the smoke slot.

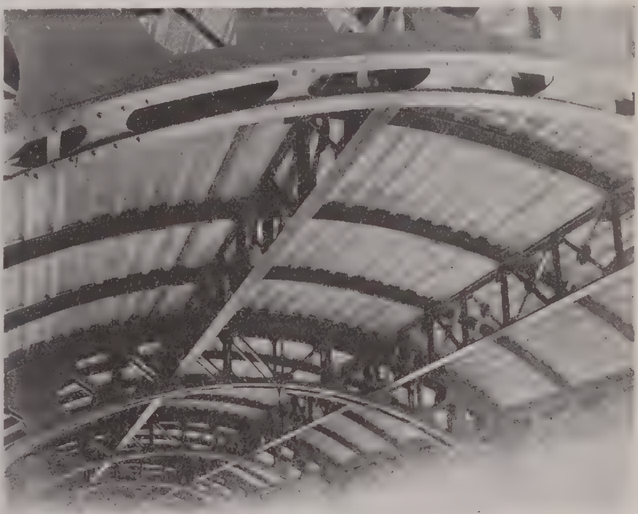
The tile with glass are of particular interest in that the glass was concreted into the slabs during manufacture. The glass is protected against stresses set up by changes in temperature, wind pressure and other strains by dipping the edges in hot asphalt preparation before inserting into the concrete tile.

The roof of the train concourse consists of five flat barrel vaults covered for the most part with Federal precast cement tile.

In the main center span and in the two low side aisles the tile are exposed on the under side, while in the two 20-ft. aisles a plastered ceiling of flat dome shape has been provided.

All tile are reinforced with galvanized rods embedded in the concrete to give the unit great strength. It is estimated that this form of tile will assure very little maintenance expense, and will be practically permanent.

The form of roof adopted for the train sheds is an outgrowth of the old type of umbrella roof so common in stations but without the disadvantages of the older type. It is assumed that this new type of roof will afford complete protection against rain and snow, will allow the smoke to get freely into the outer air and will provide plenty of ventilation, features lacking in many roofs of older construction.



Underside of Precast Cement Tile Roof Over Main Concourse

Tall Concrete Buildings in Texas

Office Buildings for Physicians, Surgeons and Dentists Are Popular in Southwest

The approaching completion of the 13-story reinforced concrete Medical Arts Building in San Antonio, Texas, brings to mind not only the increasing number of large office buildings devoted exclusively to the use of physicians, surgeons and dentists, but it emphasizes once more the great number of tall reinforced concrete structures in the state of Texas.

The popularity of buildings intended for this special occupancy is due largely to the necessity for special mechanical equipment beyond the equipment ordinarily provided in modern office buildings. In Texas no less than five large cities now have office buildings for physicians and surgeons either completed or under construction. Without a single exception the buildings have reinforced concrete structural frames and floors. They include the 19-story Medical Arts Building completed in Dallas early in 1923; the Medical Arts Buildings at San Antonio, now rapidly approaching completion; the 16-story Medical Arts Building at Houston, for which a contract was awarded in July, 1925; a similar building under construction at Fort Worth and a smaller building of similar occupancy, recently completed in Galveston.

The Dallas building is 231 feet high, and 120 by 112 feet in plan in the shape of a Maltese cross, indicative of the medical profession. The entire building is to be occupied by doctors, dentists and allied tradesmen.

The project was conceived by the Dallas County Medical Society as a building entirely for the ethical doctors of the profession. Only those doctors and dentists who belong to the doctors' or dentists' society may have office space. Each doctor was permitted to design the rooms to be occupied by him according to his own ideas and needs. The building has 58 single rooms and 192 suites, or 768 rooms in all.

Through the center of the building from top to bottom is a rotunda, which is used as providing space for waiting rooms on each floor for the offices in the wings of the building. A light shaft, 12 feet in diameter, extends through the center of the lobby. This is protected at every second floor by an invisible net, which would prevent anyone falling more than two stories if he should fall over the railing.

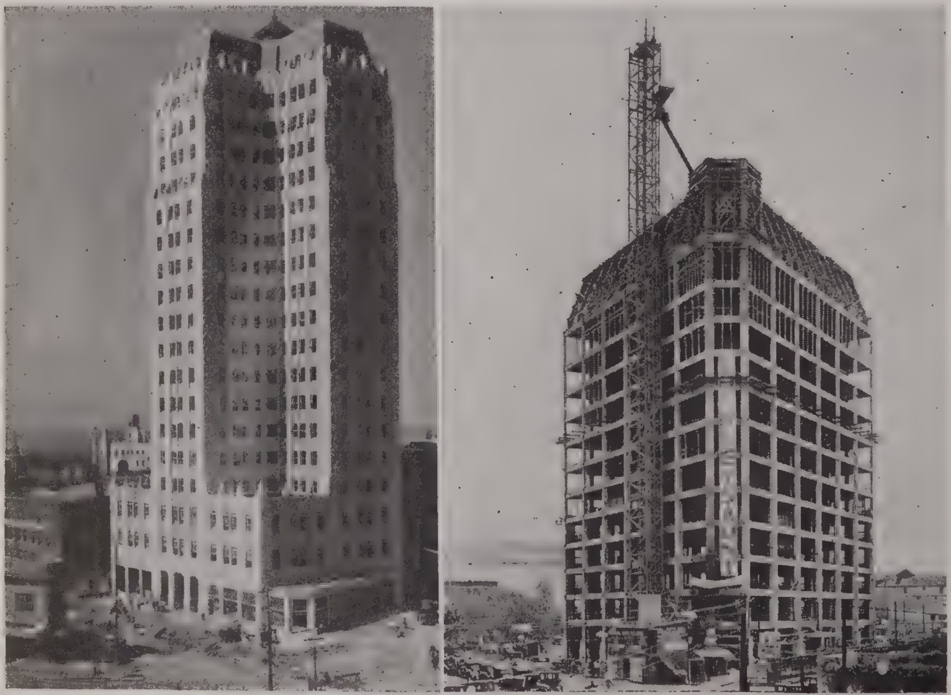
The building rests on 16 concrete pyramids, 12 feet square at the base. No steel framework was used in the building the structure being entirely of reinforced concrete.

The cost of the building and ground was $1,500,000; the cost of construction being considerably less than had the building been of steel framework.

The building was financed by Dr. E. H. Cary, a Dallas specialist in eye, ear, nose and throat diseases.

On the Dallas building the architects were Barglebaugh & Whitson, of Dallas, the structural engineer was W. J. Knight, of St. Louis and the contractor was George W. Hewitt, of Dallas. The architect for the San Antonio building is R. H. Cameron and the contractor is J. Haynes, both of San Antonio. The architects for the Houston structure are Sanguinet, Staats, Hendrick & Gottlieb, of Houston, and the contractor is Don Hall.

Among other notably tall reinforced concrete buildings



Left, the Medical Arts Building at Dallas
Right, the Medical Arts Building at San Antonio

in Texas are the Santa Fe office building, 20 stories high, built in 1924; the Hilton Hotel, in Dallas, 14 stories high, opened to the public on August 5, 1925; the Baker Hotel, in Dallas, 18 stories high, on which the concrete structural frame has been completed; the annex to the Jefferson Hotel in Dallas, 14 stories high; and the First Mortgage Company Building, in El Paso, 15 stories high, completed in 1921.

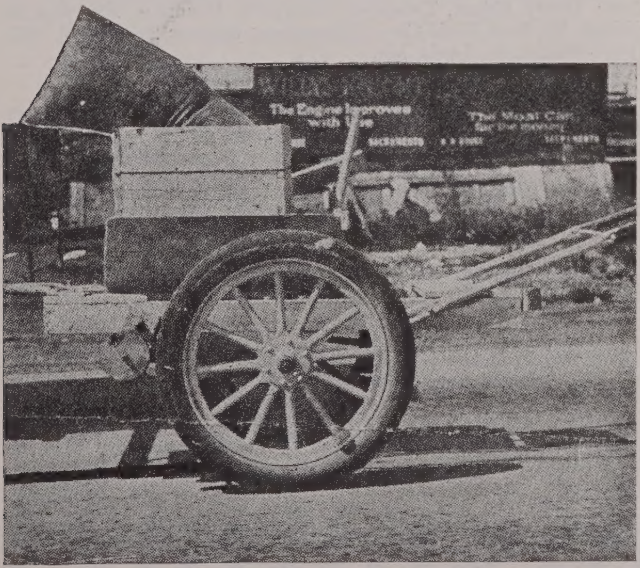
The tallest reinforced concrete building in the United States is the United Brethren Building in Dayton, Ohio, 21 stories high, completed in 1924. The architect for that building was F. J. Hughes, of Dayton and the contractors were Bergendahl & Acher of Chicago. The structure stands 276 feet above the sidewalk level. The tallest reinforced concrete building in the world will be the Palacio Salvo, a 28-story office building now under construction in Montevideo, the capital city of the South American republic of Uruguay. The total height of that building will be 338 feet above the sidewalk level. The building was illustrated and briefly described in *Engineering News-Record* for July 2, 1925, page 31.

A Homemade Device for Highway Marking

Because a traffic stripe had to be painted along the expansion joint in the center of a new pavement in California, and because available equipment proved unsatisfactory, something new had to be tried.

After some experimenting, a new device was evolved. It consisted of two units—one for painting the line and the other for distributing sawdust over the fresh paint to prevent its being smeared over the pavement by traffic, attached to a motor truck.

The painting rig consisted of a frame supporting the paint container and mounted on three wheels; the front, or marker, is a discarded Ford wheel with a felt-covered rim. There are two of these, interchangeable, one having a rim 4 inches and the other a rim 6 inches in width. The other two wheels were taken from a discarded motorcycle. The container is an old truck gas tank and at first was used as a pressure tank to spray the paint onto the marking wheel. This proved unsatisfactory, and the paint now flows down a small pipe by gravity and pours onto the pavement immediately in front of the marking wheel. A cut-off valve is attached to a long lever so it can be operated by the one pushing the machine. Behind the marking wheel, two paint brushes are placed so as to smooth the paint and work it into the pavement.

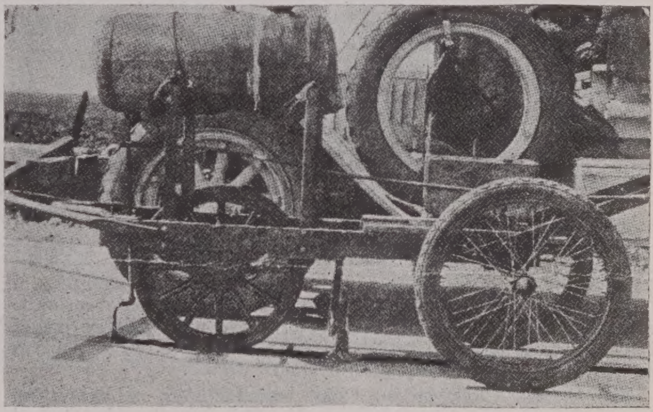


The sawdust distributor, which gives the painted stripe its protective coating

The sawdust distributor consists of a bin for holding the sawdust mounted on a pair of old Ford wheels. Two small wooden wheels connected by an axle with an eccentric are fixed so that they can be brought to bear against the large wheels. The eccentric is connected by a rod with a tin trough under an opening in the sawdust bin, agitating it and causing the sawdust to fall onto the freshly painted mark. A burlap sack is dragged behind to spread the sawdust evenly.

The line is kept straight by an out-rigger with a small wheelbarrow wheel so placed as to be easily seen by the truck operator. It is run along the outside edge of the pavement as a guide. The marking machine is fastened to the front of a truck and the sawdust distributor to the rear. They may be adjusted to mark any width of pavement.

Recently, five miles of pavement were painted and the engineers found that they could average about two miles per hour with a three-man crew at a cost of four dollars a mile.



The painting rig, showing the paint container, the feed line, the marker and the brush

The asphalt paint is made by dissolving asphalt in gasoline. A clean-cut job free from smearing is secured by using this apparatus.—*California Highways.*

New Port Improvement Projects in Finland

The port committee of the Finnish Government has recently made proposal concerning improvements of the ports of Finland to extend through a period of the next several years, Assistant Trade Commissioner Emil Kekich, Helsingfors, reports to the Department of Commerce. In Helsingfors, the capital of the country, port conditions are more important than those of other cities, approximately 50 per cent of the total import of Finland coming through Helsingfors. In a five-year program it is proposed by port authorities of Helsingfors that 150,000,000 marks (present value of mark $0.025) be invested in new construction. This construction would embrace new docks, cranes, and trackage, as well as an icebreaker, a wireless station, and warehouses. Expenditures involved in the proposal for improving port conditions, at Hango, Viborg, Abo, Sordavala and other towns amount to a total of about 67,500,000 marks.

New Books

"*Elementary Guide to Reinforced Concrete,*" by Albert Lakeman, L. R. I. B. A., M. I. Struct. E. (London, England: Concrete Publications, Ltd., 20 Dartmouth Street, S. W. 1. Price 2/—.)

This interesting book, written by a reputable architect, presents in a clear, easily understandable, way the elements of reinforced concrete theory and practice. It has been written for beginners and is intended to give sufficient knowledge to foremen and others that they may execute concrete work according to the intentions of the designer. Explaining as it does the essentials of structures, it would give knowledge to the man on the job which would teach him the necessity for following plans and specifications when it comes to placing steel, and so on. Each idea is illustrated by easily understood diagrams. Subjects covered include Loads, Reinforcement, Neutral Axis, Beams, Fixed and Supported Beams, Leverage of Beams, Bending Moments, Shearing Stress, Slabs, Columns, Walls, and Bases and Foundations. While structural practice demonstrated is that used in Great Britain, nevertheless this paper covered booklet should be placed in the hands of the men on American work. Well worth the price of two shillings, about 25 cents, that the publishers have set.

Trade Publications

The Thompson Form & Clamp Co., Fond du Lac, Wis., sends out a booklet describing common sense wall construction employing an equipment which provides an inside and an outside form and an inner collapsing form for wall construction of the tamped-in-place type. These forms are made to build walls 10 in. thick and 9⅝ in. high with each operation, either solid or hollow. Corner form units are also provided. It is a variation of the double wall system of construction with which readers of CONCRETE are already familiar, and provides simple equipment for that purpose.

The Osgood Co., Marion, Ohio, manufacturers of excavating machinery, has just issued Bulletin No. 256, featuring the Osgood ¾-yd. power shovel and its combinations. The bulletin is in the form of a 4-page folder, size 8½ x 11 in., and contains details and working ranges of Osgood power shovel and combinations.

Reinforcing Distributors Hold Chicago Meeting

The semi-annual meeting of the Concrete Reinforcing Steel Institute was held at the Drake Hotel, Chicago, on September 23. The morning session was devoted to discussing business of the Institute, after which delegates met at luncheon.

During the afternoon session, a paper on "Competition" was presented by Mr. Charles F. Abbott, Executive Director of the American Institute of Steel Construction. Papers were presented by Mr. Clarence T. Kingsbury, President, Rosslyn Steel and Cement Company; Mr. Richard L. Humphrey, Chairman of the Joint Committee; and Mr. William F. Zabriskie of the Gabriel Steel Company, Detroit.

The afternoon session was followed by dinner and the evening was devoted to the showing of a moving picture film demonstrating the process of steel manufacture at the plant of the Wisconsin Steel Company.

Mr. Abbott's paper informed the delegates how the American Institute of Steel Construction went about it to sell their institute to their industry and to improve business conditions.

As a result of the paper presented by Mr. Humphrey, the Institute went on record as favoring a single specification for concrete reinforcing and its Executive Committee was directed to investigate the matter of expense of making tests that would afford data upon which such a single specification could be based. The Executive Committee was also directed to suggest ways and means for carrying on the work.

The paper by Mr. Zabriskie told how the owner of a projected building in Detroit was able to reduce his construction costs materially by adopting reinforced concrete in place of structural steel for the structure.

At this semi-annual meeting it was decided to hold the next annual meeting in March, 1926, at Atlantic City, New Jersey.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit. Convention, Feb. 23-26, 1926, Hotel Sherman, Chicago, Ill. Exhibits.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago. Convention, Feb. 22-23, 1926, Hotel Sherman, Chicago, Ill.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 West Thirty-ninth St., New York City. Annual meeting, for members only, December 10, 1925.

Associated General Contractors of America; D. H. Sawyer Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 West Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Frank Burton, President, J. F. Downey, City Hall, Cambridge, Mass., Secretary.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, 160 North La Salle St., Chicago. Annual meeting, March, 1926, Atlantic City, N. J. Date not selected. No exhibits.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City. Convention, October 26, 27, 28, 1925, Hotel Statler, St. Louis, Mo.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East Twenty-second St., New York City.

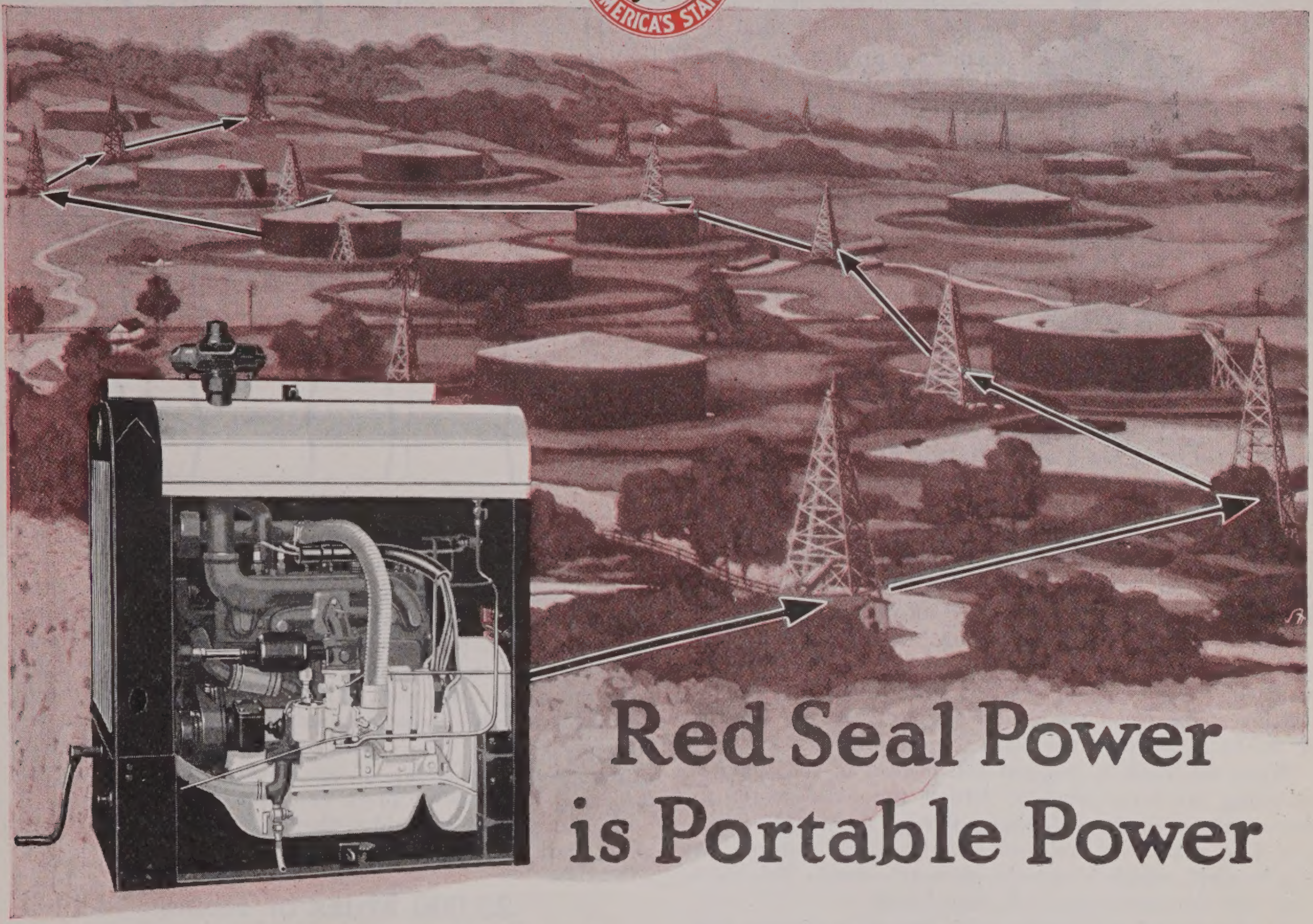
National Sand and Gravel Association; T. R. Barrows, 903 Munsey Bldg., Washington, D. C., Secretary.

The National Lime Association; Burton A. Ford, Secretary, 918 G. Street, N. W., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington St., Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, 425 E. Water Street, Milwaukee.

Dependable Power for Every Purpose



RED SEAL High Speed Multi-cylinder Motors have added new advantages to the well recognized portability of the gasoline motor for industrial power.

Low weight per horsepower, as well as low fuel consumption for the weight, form the basis of these Red Seal Motor advantages.

Readily moved from job to job and from point to point on the job, a Red Seal Motor combines the advantages of its own portability with the ease of transporting its fuel supply.

Long and serious study of industrial requirements were made by Continental to add to the already unlimited fund of knowledge accumulated in nearly 25 years of gasoline motor experience.

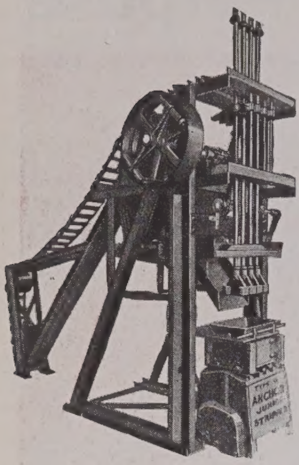
Continental then applied its highest technical skill to the design and construction of power plants to meet every industrial condition. The results are Red Seal Industrial Motors.

Put Your Power Problems
Up To "Power Headquarters"

CONTINENTAL MOTORS CORPORATION
Offices: Detroit, Mich., U. S. A.
Factories: Detroit and Muskegon

Continental Motors

New Model "G" Anchor Junior Stripper



The new model "G" Anchor Junior Stripper that has greater efficiency

The rapid advancement of concrete building unit manufacture, along the line of quantity production, has made the stripper type of block machine more popular than ever. The practice of running two and three shifts of men has made necessary machinery that will stand hard punishment, and in operation will do its work with a minimum strain on the operators.

With these considerations in mind, engineers for the Anchor Concrete Machinery Co., Adrian, Mich., designed the new Model "G" Anchor Junior Stripper, which has three new features.

With any stripper which strips the block from the mold by a double toggle action, it is sometimes hard to start the block, and when it is raised about two inches and the second toggle, or lever, comes into play the operator has to overcome a new resistance. In the new Anchor model the stripping mechanism is a single simple toggle actuated by cam gears. This is said to have twice the starting efficiency of the double toggle type, and the rise of the block through the mold is gradually accelerated.

When the block is stripped out, instead of the operator releasing the lever slightly, letting the pallet carefully down onto a catch, with the new type the toggle is adjusted so that when stripped out the block rests on the toggle itself, which is exactly on dead center. This saves time and the possibility of broken block.

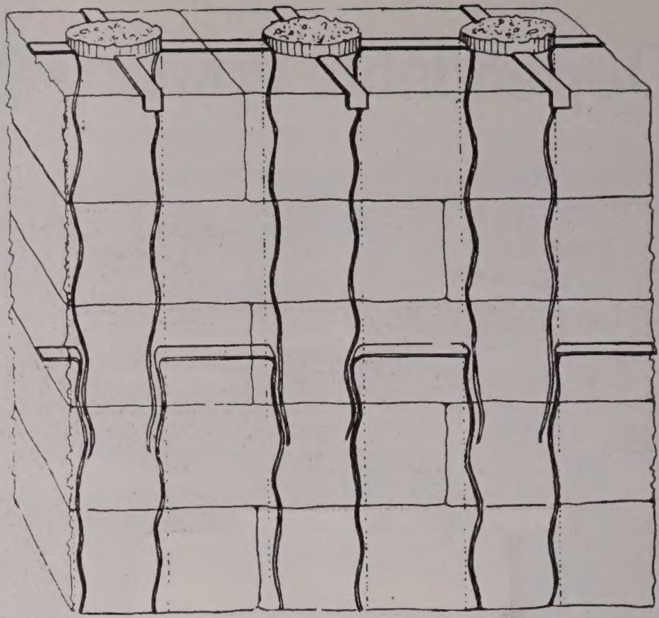
In the Model "G," the mold box is equipped with hardened and ground 1/4-in. steel liner plates, reversible, so that the mold box will have many times the life of the cast-iron type of mold box, besides making a block with better faces, say the manufacturers.

Announcement is also made of important refinements on all models of Anchor tampers. The crankshaft is three times the previous strength, crank-arms are drop-forged, with two-piece hubs. A new and improved brake assembly eliminates possible crystallization of parts. All castings subject to shock are malleable, the frame is heavier, and longer tamp-rod bushings have been installed.

New System of Wall Construction

A light weight block of insulating material, which serves as a base for exterior and interior stucco and plaster without furring strips, and reinforced concrete, which is poured without the use of temporary molds, are the constituent parts of a new and increasing system of wall construction sponsored by the Stockade Building System, Inc., 103 Park Ave., New York City. The blocks are composed of an exceedingly light, fibrous material with biscuit-like texture. This material is said to be moistureproof, verminproof, and an excellent insulation against heat, cold, and sound, and is highly fire resistant.

The blocks are made in the proportion of the common brick, as this is accepted module for achieving a pleasing effect in wall construction. Each block is pierced by two round holes and weighs only 4 pounds, the equivalent of eight bricks in volume but weighing less than one brick. This point is important when it comes to the cost of transportation and of delivering to the scaffoldings.



The blocks are laid like brick but without mortar, care being taken that the holes are in exact alignment. Three courses are laid up and then concrete is poured and tamped into the holes thus forming continuous columns of concrete throughout the wall. These columns are reinforced by means of steel strips applied as shown in the accompanying diagram. Each strip extends the height of four courses with an overlap of one course. These strips are also used for tying on brick or clapboard facing.

Special courses are laid at the level of joist support and about wall openings.

23,000 Miles of Road Built Last Year

Twenty-three thousand miles of highways were built to grade or surfaced on the State systems in 1924, according to information collected by the Bureau of Public Roads of the United States Department of Agriculture from the various State highway departments. More than 17,000 miles were surfaced. The surfaced mileage constructed by types was as follows:

Sand-clay	1,385
Gravel	7,660
Waterbound macadam	467
Surface-treated macadam	1,000
Bituminous macadam	997
Sheet asphalt	120
Bituminous concrete	564
Cement concrete	4,850
Brick and other block pavements	164

The bureau estimates that at the end of 1923 there were surfaced roads in the State systems totaling 111,400 miles. Adding the mileage surfaced in 1924, after making allowance for the fact that a portion of the new work consisted of the resurfacing of old roads, it is indicated that approximately half of the 251,610 miles embraced in the State systems were surfaced at the beginning of the present year. These figures represent work done under State supervision, including Federal-aid work, but do not include county or local work off the main State systems. Progress in 1925 should be at least as great as in 1924 according to the best information available.